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LA PETITE INDUSTRIE ET LA POLITIQUE INDUSTRIELLE PORTUGAISE

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N° 369

LA PETITE INDUSTRIE ET LA POLITIQUE INDUSTRIELLE PORTUGAISE

D.2.3.

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1. Le continent portugais, dont l'aire totale est de 88.500 Km2, a une population résidente de l'ordre des 8 millions et demi, dont 4 millions environ peut être considérée comme population active. Au cours de l'année de 1960, le produit intérieur brut sur la base du coût des facteurs s'élevait à 62,1 millions d'escudos, la répartition par secteurs d'origine étant la suivante:

Agriculture, sylviculture et pêche:	15,9	millions	d'escudos
Industrie:	25,5	"	"
Services:	20,7	"	"

d'où il ressort que l'activité industrielle a fourni 41% environ de la valeur totale (1). Une population industrielle de 700.000 personnes, occupées dans 73.364 établissements industriels, a contribué pour ce volume d'activité.

2. Au cours de notre analyse de la dimension de ces établissements, nous avons dû faire face à un certain nombre de limitations qui en ont forcément réduit la valeur. D'une part, les données statistiques dont nous pouvons disposer à l'heure actuelle n'indiquent que la répartition de la population industrielle par établissements de 1 à 10, de 11 à 100, de 101 à 1.000 et plus de 1.000 et non pas le nombre d'établissements par ces mêmes catégories. D'autre part, les mêmes sources statistiques apportent ces données par classes C.I.T.I., qui comportent dans la majorité des cas des industries très diverses, et cette circonstance ne permet pas une analyse sectoriale de la dimension aussi profonde qu'il serait à désirer. Nous espérons pouvoir faire disparaître ces difficultés dans un bref délai, dès que nous pourrons disposer d'éléments plus détaillés, susceptibles de nous permettre d'apprécier la validité des conclusions auxquelles nous avons maintenant abouti.

Il va de soi que le volume du personnel occupé dans un établissement n'est nullement un indicateur optimum de sa dimension. Toutefois, lorsqu'il s'agit d'économies comme la nôtre, d'un faible niveau d'industrialisation, la différence constatée entre les indications données par cet indice et la réalité présente une importance relative bien moindre que dans le cas d'économies d'un degré d'industrialisation élevé, en vertu de la faible mécanisation existante.

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(1) Source: Institut National de Statistique. Un recensement de la population, dont on ne connaît que le chiffre provisoire de la population résidante, a été réalisé en 1960. En ce qui concerne la population active, dont l'évaluation est en cours, nous avons été obligés de présenter une estimative rudimentaire, dont nous considérons comme les seuls responsables.

(2) L'Institut National de Statistique a réalisé entre 1957 et 1959 une enquête industrielle qui adopté comme unité l'établissement tel qu'il est défini par le C.I.T.I. Cette enquête a porté sur tous les établissement industriels du continent portugais dont les activités sont comprises dans les classes 11 à 40 et 51 de cette classification. Elle est notre source principale pour présenter les différentes données figurant dans cette communication.

En examinant les totaux inscrits au tableau I, en annexe, on est amené à conclure, sans chercher à définir des points moyens pour chaque catégorie d'établissements, que ceux de moins de 10 personnes en constituent la grande majorité, ce fait confirmé, d'une façon approximative, par la dimension moyenne totale --- 9,1. Ces mêmes chiffres nous font croire que la catégorie de 11 à 100, à côté de la première, présente elle aussi une importance considérable.

En adoptant maintenant l'optique de la classification C.I.T.I., on est amené à constater que la dimension moyenne de chaque classe est en général faible, ne s'élevant jamais jusqu'à 1.000 personnes et ne dépassant les 100 que pour 3 classes (industrie du tabac, métallurgiques de base et diverses (3).

Le fait souligné en ce qui concerne le total, c'est-à-dire que la population occupée dans les établissements de moins de 10 personnes est relativement nombreuse, est confirmé dans la plupart des classes. À cet égard, les classes des industries d'alimentation, de boissons, de chaussures et d'articles de vêtement, d'ameublement, de tannerie et d'articles de cuir, de produits métalliques divers, ainsi que celles de différentes industries transformatrices, se font particulièrement remarquer. Parmi 14 des classes indiquées au tableau I, ont peut constater une dimension moyenne entre 10 et 100, les classes industries textiles et des dérivés du pétrole et du charbon figurant en tête avec une dimension moyenne dépassant 50. Un examen de la dimension moyenne résultant de l'exclusion de la catégorie 1 à 10 aurait un intérêt certain, mais une telle tâche allongerait excessivement cette communication.

3. Dans la phase initiale des études sur ce sujet, phase où nous nous trouvons, nous avons adopté un critérium statistique, basé sur le nombre des salariés, pour définition de petite industrie: celle qui est constituée par des établissements occupant moins de 100 personnes.

a) - Le tableau II annexé permet de constater que plus de la moitié de la population industrielle du continent portugais est occupée dans des établissements ayant moins de 100 personnes --- 56%, contre 44% travaillant dans des établissements ayant plus de 100 personnes. On peut constater en outre que la moitié environ (25% du total) des personnes occupées dans des établissements de 1 à 100 sont occupées dans des établissements ayant un personnel compris entre 1 (dans ce cas dirigeant) et 10 personnes, ce groupe étant constitué, dans sa grande majorité, par de l'activité artisanale. Toutefois, cette répartition n'est pas homogène chez toutes les classes C.I.T.I.. En fait, si l'on examine les cas extrêmes, on est amené à constater que si dans les industries métallurgiques de base la répartition est de 6% de la population occupée dans des établissements jusqu'à 100 personnes, contre 94% dans ceux ayant plus de 100, c'est la répartition exactement inverse qu'on trouve dans l'industrie de la chaussure et des articles de vêtement. Si nous tenons compte du fait que dans la majorité des classes la population occupée des établissements ayant moins de 100 personnes dépasse les 40% de la population totale, nous pouvons comprendre la grande importance de la petite industrie dans le continent potugais, surtout en ce qui concerne les industries de l'alimentation, des boissons, de la chaussure et de l'habillage, du bois et du liège, de l'ameublement, de la typographie et de l'édition, de la tannerie et des articles en cuir, des produits métalliques, de la construction de machines, ainsi que les industries transformatrices et le bâtiment, et exceptées les industries des textiles, des articles en caoutchouc, des dérivés du pétrole et du charbon, les métallurgiques de base et les industries diverses.

En examinant un à un les deux types d'établissements qui constituent au tableau II la petite industrie, on peut constater que dans le cadre de ces classes C.I.T.I., les établissements de 1 à 10 personnes occupent une place de choix parmi les industries de l'alimentation, des boissons, de la chaussure et articles d'habillage,

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(3) Elle comprend les établissements industriels ne pouvant pas s'inscrire dans aucune classe C.I.T.I.

d'ameublement, de tannerie et articles de cuir, des produits métalliques divers et les industries transformatrices diverses. Cette importance devient remarquable lorsqu'on examine de près deux dernières colonnes du tableau II, où les établissements de 1 à 10 personnes ne figurent plus. Ceci donne comme résultat, pour la majorité des classes, une approximation de la répartition de la population entre des établissements ayant moins de 100 et ayant plus de 100 personnes, par rapport aux 5ième. et 6ième. colonnes. Il y a même inversion des positions pour trois des classes.

b) - Sans chercher à aborder une question délicate et hors du cadre de cette communication comme la problématique du développement régional, nous avons fait coïncider géographiquement l'analyse régionale de la petite industrie et une division du potugais dans trois types de zones, déterminées suivant leur contribution pour la production industrielle totale (voir la carte géographique de la figure I). Cette division a pour le moins deux défauts: le critérium adopté n'est pas le seul indicateur du niveau d'industrialisation régionale; les zones, n'étant que des sommatoires de districts - divisions administratives - en vertu des données statistiques dont nous disposions, ne correspondent pas exactement à des régions économiques bien caractérisées.

Toutfois, en examinant les chiffres inscrits à la figure I, on peut constater que les zones du type A d'une surface inférieure aux zones des types B et C, ont une population, soit totale, soit industrielle, numériquement placée bien au-dessus de ces dernières, leur participation dans la production industrielle du pays s'élevant en même temps à 77% environ contre 15% e 7% pour les zones B et C respectivement.

La répartition de la population industrielle par catégories d'établissements est la suivante:

Établissements de :	1 à 10 p.		- 11 à 100 p.		- 1 à 100 p.		- plus de 100 p.	
	1000 p.	%	- 1000 p.	%	- 1000 p.	%	1000 p.	%
Zones: A	94	19	156	32	250	51	239	49
B	46	35	37	29	83	64	48	36
C	36	49	21	29	57	78	16	22

Ceci permet d'arriver à la conclusion que la petite industrie est prédominante dans toutes les zones, mais qu'une telle prédominance prend des aspects frappants dans les zones du type B et surtout dans celles du type C. En fait, alors que dans les zones du type A la répartition de la population industrielle par des établissements de moins de 100 personnes et de plus de 100 personnes est équilibrée, dans les zones du type B la population occupée dans la première catégorie d'établissements est un peu inférieure au double de la restante, et, dans celles du type C, elle est nettement supérieure à ce rapport. Il y a lieu de souligner également la modification de la répartition entre établissements de 1 à 10 personnes et ceux de 11 à 100 personnes au fur et à mesure que nous passons des zones A vers les zones B et C; tandis que dans les zones du type A la population occupée dans des établissements de 11 à 100 personnes est la prédominante, dans celles du type B et C, notamment dans ces dernières, la position change au profit des établissements de moins de 10. Il faut, donc, en conclure que dans les zones B et C la prédominance est celle des établissements de moins de 10 personnes, qui dans leur majorité constituent de l'industrie artisanale.

D'autre part, et examinant maintenant les chiffres absolus, on est amené à conclure que les établissements considérés comme de la petite industrie, soit ceux de 1 à 10 personnes soit ceux de 11 à 100, soit encore les deux groupes ensemble, sont plus nombreux dans les zones du type A que dans celles des types B ou C. Nous nous trouvons une fois de plus placés devant le faible niveau d'industrialisation de ces zones.

4. En prenant comme base la caractérisation sectorielle et régionale de la petite industrie au Portugal continental, nous nous efforcerons de présenter un certain nombre d'éléments pouvant contribuer pour l'élaboration d'une politique de développement industriel basée sur de petites unités, tout en tenant compte des insuffisances des

données statistiques, déjà soulignées aux paragraphes antérieurs, et sans oublier le fait que nous ne sommes qu'au début des travaux sur cette matière.

Si nous tenons compte à la fois des réalités exposées aux paragraphes antérieurs, et du fait que le Portugal est un pays où l'accès du marché de capitaux est difficile, où les cadres de personnel supérieur ou de techniciens qualifiés sont réduits, où la main-d'oeuvre non occupée ou à demi occupée est abondante, où le marché de consommateurs est réduit, rendant difficile la production en grandes séries, où le réseau des transports dans certaines des zones est insuffisant, où la possibilité d'établir des pôles de croissance au moyen de grandes entreprises dans les zones les moins favorisées est difficile, et où, en outre, la productivité moyenne est peu élevée, nous trouvons dans la petite industrie un potentiel très riche pour encourager le développement économique du pays, dans équilibre parfait avec des politiques générales de développement agricole et industrial. Les petites unités pouvant être installées dans certaines régions et celles qui pourraient subir un processus de modernisation, mettenant à profit les faibles ressources fournies par la structure actuelle, pourraient donner une solution à la fois à des problèmes de développement de l'activité industrielle, en ce qui concerne soit l'utilisation d'une plus grande quantité de main-d'oeuvre soit une augmentation de productivité dans l'industrie.

Cette idée de modernisation se pose, quant à nous, à deux niveaux différents. Si elle est appliquée à la petite industrie, c'est-à-dire à une partie ou à la totalité d'un secteur industriel constitué par de petites unités, elle aura une signification différente de celle qui lui serait donnée par une application au petit établissement industriel isolé, et où l'on ne cherche plus obtenir une augmentation de l'efficacité économique de ce secteur, mais bien de l'unité elle-même, quelle que soit l'origine de l'initiative d'une telle action.

Ces unités appartiennent essentiellement à trois types différents, à savoir:

a) - D'artisanat artistique ou folklorique, ou bien de fabrication artisanale d'objets divers;

b) - Unités présentant déjà une efficacité relativement élevée, et qui, tout en restant petites, peuvent recevoir une action de modernisation profitable, moyennant des services communs de formation technique, de consultation ou de recherche, etc.;

c) - Unités intermédiaires, c'est-à-dire, présentant des caractéristiques mixtes de petites unités modernes et artisanales.

Si l'on examine ces différents types d'unités dans leur encadrement propre de secteurs industriels (dans un sens moins large que les classes C.I.T.I.) ou régional, ils nous apportent une problématique de développement qui, bien que présentant des traits communs devant la grande unité, présente des aspects distincts de petite unité et de petite industrie.

Aussi, au cours d'études sectoriales ou régionales que nous allons entreprentre dans un bref délai dans le domaine des petites unités, deux cas différents peuvent se présenter:

a) - Modernisation de la petite industrie, amenant soit à la modernisation des unités existantes soit à la création d'unités d'une plus grande dimension, mais où il n'y a pas une préocupation directe de modernisation de chacune des unités;

b) - Modernisation de la petite industrie moyennant la modernisation de chacune desunités existantes, prises une à une, tout en conservant la dimension.

Le premier cas est en fin de compte un problème de dimension d'industrie, envisagée suivant la dimension moyenne du secteur. Essentiellement, il s'agit du problème des petites unités anacroniques qui existent dans la "fabrication artisanale d'objets divers".

5. C'est dans cet aspect de réorganisation structurelle de petite industrie que nous tenons à présenter ici un certain nombre de cas concrets. La Loi 2.005, promulguée le 14 mars 1945 et généralement connue sous la désignation de Loi du Développement et la Réorganisation Industrielle, consacre une premiere partie à l'installation d'industries nouvelles et une deuxième à la réorganisation des industries existantes, définissant les

buts à atteindre par une telle politique: satisfaction des exigences des marchés intérieur et extérieur et amélioration des conditions de vie, notamment celles du travailleur.

Les formes de réorganisation prévues par cette loi sont les suivantes:

a) - Concentration dans des unités d'un plus grand rendement économique et perfection technique;

b) - Remplacement de l'équipement et autre matériel dépassé et de faible rendement économique, par un autre d'une plus grande efficacité;

c) - Accroissement d'installations de façon à réaliser des cycles de fabrication plus avantageux et intégration d'industries dans les cas où celle-ci soit considérée comme convenable;

d) - Vente d'installations considérées comme excessives;

e) - Remplacement de bâtiments impropres, tenant principalement compte de l'aspect de la salubrité;

f) - Adoption de règles de normalisation de produits et de coordination de fabrication;

g) - Adoption de méthodes d'organisation scientifique du travail.

La loi indique par la suite les différentes modalités de l'aide du Gouvernement aux entreprises désireuses de se réorganiser --- moyennant la concession de crédits, l'exemption de certains droits douaniers et autres avantages déterminés par la nature particulière de l'entreprise.

Cette loi n'a pratiquement trouvé d'application concrète, sauf certains cas isolés qui se sont auparavant présentés, qu'il y a trois ou quatre années, au moment où le Portugal a été placé devant le problème des intégrations économiques, et, donc, celui de la concurrence des industries nationale et étrangère. Il est clair que cette loi se situe dans un domaine bien plus vaste que celui que nous abordons ici --- celui de la petite industrie. Toutefois, il est curieux de constater qu'au cours de ces dernières années elle a été utilisée, nous pouvons dire dans sa totalité, par rapport à des industries extraordinairement divisées où l'on trouve une grande prédominance de petits établissements, dans leur majorité ayant moins de 10 personnes, que nous avons défini auparavant comme des unités de fabrication artisanale d'objets divers. Aussi nous revenons aux problèmes qui nous occupent, bien que par le biais d'une politique qui ne saurait être considérée comme strictement orientée vers le développement de la petite industrie.

Les plans de réorganisation sont déjà élaborés pour quatre industries - vaisselle et autres articles en aluminium laminé, conducteurs électriques, coutellerie et verre - et les études d'autres réorganisations sont en cours à l'heure actuelle. L'initiative de ces études est venue parfois du Gouvernement et parfois des industriels eux-mêmes, les motifs invoqués étant dans tous les cas une plus grande possibilité de survivance dans le cadre d'une intégration économique. Les commissions qui en ont été chargées, dont font partie des représentants des industriels intéressés, ont adopté une méthodologie commune, bien qu'adaptée à chacun des cas spéciaux.

Cette méthodologie peut être génériquement résumée dans les points suivants:

a) - Étude de l'industrie à l'échelle nationale portant sur les principales caractéristiques, notamment le nombre d'établissements, leur dimension et leur localisation, l'approvisionement en matières premières, les nombreux aspects de la production, leur organisation et contrôle, la main d'oeuvre, les coûts, la productivité et le rendement, les marchés et leurs différentes importances pour l'industrie, la normalisation, la situation financière.

b) - Analyse de la situation de l'industrie dans des pays étrangers et comparaison des caractéristiques trouvées avec celles de l'industrie nationale, dans une première tentative de trouver des solutions suivant celles adoptées dans ces pays.

c) - Définition des principaux problèmes à solutionner, telles que la dimension des établissements, l'approvisionement en matières, le personnel nécessaire à l'industrie et le destin à donner au personnel disponsable, la détermination des produits à

fabriquer et leur normalisation, les problèmes d'organisation, de contrôle et des marchés.

Sur la base de ces éléments, les commissions élaborent les plans respectifs, soumis à l'accord des industriels intéressés. Ces plans ont dans leur majorité préconisé la concentration d'établissements, sans provoquer dans tous les cas le remplacement par de grandes unités, en vertu de la dimension déjà si faible de celles qui constituent ces industries. En même temps, elles s'efforcent de définir les meilleures dimension des nouveaux établissements, ainsi que les besoins et les sources d'un meilleur approvisionement des matérimux, les équipements les plus convenables, la formation technique nécessaire, les productions à réaliser et les meilleurs règles de normalisation, les marchés possibles, les services de défense des intérêts de l'industrie ou la coorpération dans ce but d'organisations déjà existantes, et enfin l'aide directe à accorder par le Gouvernement.

Il est clair que les cas de modernisation dans le cadre d'une politique de développement de la petite industrie, intégrée dans une politique de développement économique général, présenteraient des aspects différents. Toutefois, nous espérons tirer de ces cas l'expérience utile pour les actions contrétes que nous allons entreprendre à bref délai.

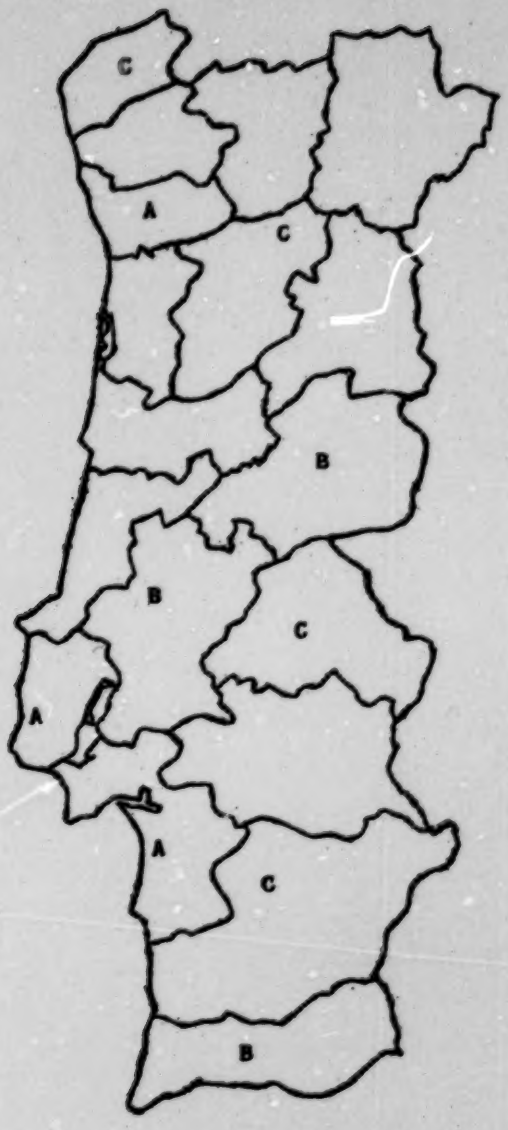
TABLEAU 1
LA DIMENSION DANS LA STRUCTURE INDUSTRIELLE PORTUGAISE

Classes C.I.T.I:	Population industrielle des établissements de n personnes				Population industrielle de tous les établissements	Nombre total des établissements	Dimension Moyenne
	n=1 à 10	n=11 à 100	n=101 à 1000	n=plus de 1000			
11 à 19	5.450	6.820	6.166	11.203	29.639	1.819	16,4
20	43.684	21.484	28.195	-	93.363	20.393	4,6
21	3.132	1.562	1.148	-	5.842	1.524	3,9
22	-	-	1.626	-	1.626	2	813
23	4.109	26.606	65.468	14.923	111.106	2.065	53,8
24	36.126	15.143	3.366	-	54.635	17.184	3,2
25	11.164	26.534	12.579	1.899	52.176	4.433	11,8
26	8.156	5.415	2.263	-	15.834	3.173	5
27	1.047	4.246	3.858	1.378	10.429	388	26,9
28	2.951	7.819	5.313	-	16.083	994	16,2
29	1.812	2.458	1.010	-	5.280	817	6,5
30	561	1.076	3.234	-	4.871	215	22,7
31	2.121	6.425	12.739	-	21.285	851	24,6
32	27	149	111	1.294	1.581	20	79,1
33	9.787	13.658	20.999	2.588	47.032	3.220	14,6
34	17	80	689	1.008	1.794	14	128,1
35	14.773	17.470	16.957	2.530	51.730	7.551	6,9
36	1.265	5.636	4.039	1.551	12.491	493	25,3
37	1.497	3.602	5.582	-	10.681	660	16,2
38	9.464	11.549	12.424	11.742	45.179	4.204	10,7
39	6.398	6.062	2.946	-	15.406	2.641	5,8
40	12.010	29.381	31.656	5.166	78.213	3.581	21,8
51	182	1.060	1.531	-	2.773	83	33,4
Div.	52	416	2.157	1.305	3.930	39	101
Total	175.785	214.551	246.056	56.587	692.979	76.364	9,1

TABLEAU 2

LA PETITE INDUSTRIE DANS LA STRUCTURE INDUSTRIELLE

Classes C.I.T.I.	Population industrielle	Pourcentage de la population industrielle travaillant dans des établissements de				Pourcentage de la population industrielle des établissements de plus de 10 personnes travaillant dans des établissements de	
		1 à 10 personnes	11 à 100 personnes	1 à 100 personnes	plus de 100 personnes	11 à 100 personnes	plus de 100 personnes
11 à 19	29.639	18%	23%	41%	59%	28%	72%
20	93.363	47%	23%	70%	30%	43%	57%
21	5.842	53%	27%	80%	20%	58%	42%
22	1.626	-	-	-	100%	-	100%
23	111.106	4 %	24%	28%	72%	25%	75%
24	54.635	66%	28%	94%	6%	82%	18%
25	52.176	21%	51%	72%	28%	65%	35%
26	15.834	52%	34%	86%	14%	71%	29%
27	10.429	10%	40%	50%	50%	44%	56%
28	16.083	18%	49%	67%	33%	60%	40%
29	5.280	34%	47%	81%	19%	71%	29%
30	4.871	12%	22%	34%	66%	25%	75%
31	21.285	10%	30%	40%	60%	34%	66%
32	1.581	2%	9%	11%	89%	10%	90%
33	47.032	21%	29%	50%	50%	37%	63%
34	1.794	1%	5%	6%	94%	4%	96%
35	51.730	28%	34%	62%	38%	47%	53%
36	12.491	10%	35%	55%	45%	50%	50%
37	20.681	14 %	34%	48%	52%	39%	61%
38	45.179	21%	25%	46%	54%	32%	68%
39	15.406	42%	39%	81%	19%	63%	33%
40	78.213	15%	38%	53%	47%	44%	56%
51	2.773	7%	38%	45%	55%	41%	59%
Div.	3.930	1%	11%	12%	88%	11%	89%
Total	692.979	25%	31%	56%	44%	41%	59%



P O R T U G A L
Métropole
(Continent)

Superficie Totale: 88.517 Km2
Population résidente: 8.510.799
Population industrielle: 692.979

- Frontière de district

Zones:	A	B	C
Superficie (Km2)	15.606	25.856	47.055
Population résidente (1.000 personnes)	4.378	1.988	2.345
Population industrielle (" ")	489	131	73
Production industrielle (%)	77,6	15,0	7,4

Figure I

E/CONF.39/D/45
SUMMARY
16 Oct.1962
ENGLISH
ORIGINAL : FRENCH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.2.3

Portugal

SMALL SCALE INDUSTRY AND PORTUGUESE INDUSTRIAL POLICY

By V. DIAS SANTOS,
F. PINTO COELHO,
Assistants at the National Institute
for Industrial Research,
Industrial Economy Study Division

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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SMALL SCALE INDUSTRY AND PORTUGUESE INDUSTRIAL POLICY

By
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ASSISTANTS AT THE NATIONAL INSTITUTE FOR INDUSTRIAL RESEARCH,
INDUSTRIAL ECONOMY STUDY DIVISION.

SUMMARY

Generally speaking, the structural condition known as "in process of development" connotes very specific characteristics in the industrial structure included in such a context.

2. This communication is the result of a first attempt by the Industrial Economy Study Division of the National Institute for Industrial Research to establish with objective reality the present role played by small units in the industrial structure, and also the broad lines of a policy designed to encourage them to follow the dynamic rhythms appropriate to swift economic development. It presents a brief analysis of the typical size of industrial establishments in metropolitan Portugal, and notes, in conclusion, a clear predominance of the small unit (defined according to a statistical criterion) both by industrial sectors (C.I.T.I. classification) and by regions. In this connection an interesting factor is the existence of a larger number of small establishments in the most industrialised zones, as compared with the more backward regions, despite a clear relative predominance of small-scale industry in the latter.

3. This analysis draws attention to the regions where measures could be more fruitful, and also to a certain number of factors which could play a part in the elaboration of a development policy for small-scale industry, based on a general development policy.

4. Aspects of the reorganisation of small-scale industry already in existence have been specially emphasised, and the last part presents a line of action adopted in Portugal in a certain number of concrete cases of industrial modernisation. These latter, though not specifically directed within the framework of a policy for small-scale enterprises, offer experiences which can be profitable for working out such a policy.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item:D.6.1

United Arab Republic

POSSIBILITIES OF PRODUCING VISCOSE, RAYON AND NYLON FROM AVAILABLE LOCAL RAW MATERIALS AND BLENDS WITH NATURAL FIBRES

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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POSSIBILITIES OF PRODUCING VISCOSE RAYON AND NYLON FROM AVAILABLE LOCAL RAW MATERIALS AND BLENDS WITH NATURAL FIBRES

H.M. El-Behery, Ph.D.
Faculty of Engineering, Alexandria University

I INTRODUCTION

1. Production of man-made fibers on industrial scale started in the United Arab Republic in 1950 with the production of viscose rayon filaments which totalled 1870 tons per year and staple fiber of 1312 tons per year. In 1955 another establishment has started the production of viscose filament with 751 tons/year. Both companies have increased their production and together attained in 1961 an output of 6749 tons of continuous filament rayon, achieving an increase of 261% to 1950 production. Also the staple fiber production has increased reaching 4343 tons in 1961 with a 231% increase compared with 1950. The steps of this increase and its rate over such period of time are shown in Table 1 and illustrated in Figure I.

2. Up to 1957 all viscose filaments and staple fiber production was satisfying most of the needs of the local market consumption. However, in 1957 exportation started with 1.5% in filament form and 11.3% in cloth form of the total production. These amounts increased year by year until they reached 23% of the total production for filamented yarn, 11.2% of viscose staple and 17.4% in cloth form. Table 1 also shows the imports and exports of the different forms of the rayon production.

3. As the viscose rayon production was based on imported cellulose pulp, increase in production meant an equivalent increase in the imported pulp as shown in Table 1. This fact encouraged research workers in the UAR to investigate the possibility of cellulose pulp production from the available local resources. Steps were also taken to increase the production of other chemicals such as caustic soda, sulphuric acid, carbon disulphide, etc.. according to well defined plans which took account of the requirements of other industries as well.

In collaboration with:
S.T. El-Serafi and A.K. Wahbi

4. The continuous growth of the viscose rayon industry was accompanied by an increase in the importation of synthetic yarns and products, particularly Nylon. Accordingly, in 1957 it was decided to erect a plant for the production of Nylon 6 which was completed in 1958. It started with a production amounting to 34 tons per year of Nylon filament and 101 ton per year of nylon staple. By the end of 1961 these production figures were raised to 175 tons / year of filament and 144 tons per year of nylon staple. This represents an increase of product equivalent to 41.5% for the former and 42.5% for the latter.

5. At the present projects for expanding the existing nylon plant and for erecting other plants for the production of acrylic and polyester fibers are under investigation. These will be provided with intermediate for production from the new petrochemical plant.

II. LOCAL AVAILABLE RESOURCES OF RAW MATERIALS FOR VISCOSE RAYON

6. Practically all the main chemicals utilized in the manufacture of viscose rayon are now produced in the UAR. Woodpulp is the only main raw material which is still imported. To render the industry independent a study of the local available resources for raw materials which could be utilised in the production of cellulosic pulp with specifications suitable for rayon production has been carried out. Obviously attention was given to natural cellulosic resources which could be used economically and in adequate amounts to satisfy the needs for a pulp suitable for viscose production. The materials that came under consideration, and were investigated are:

a) Bagasse
b) Rice straw
c) Cotton linters
d) Cotton Waste
e) Eucalyptus wood
f) Reeds (Phragmites communis and Arunda donax)

III. RESEARCHES CARRIED ON THE ABOVE MATERIALS WITH THE OBJECT OF EXAMINING THEIR SUITABILITY FOR THE PRODUCTION OF VISCOSE PULP

7. The National Research Centre of the UAR, in cooperation with the Rayon Producers organized a research scheme to study the possibility of substituting the imported wood pulp for pulps produced from the previously enumerated raw materials. In the following, a summary is given of the main results obtained:

(a) Bagasse:

(1) Chemical researches (1) on bagasse showed that the pith part, which forms about 25% of the raw material, has lower cellulose content and higher ash content than the fibrous part. Consequently, investigations (2) carried out to study the amount of pith that ought to be removed to produce pulps suitable for viscose, stated that from 40% to 50% of the pith had to be removed. Also, various

methods of the removal of the pith had been studied (3) and different pulping procedures had been suggested in literature (4,5,6,7,8). The aim of the research (9) carried in the N.R.C. was to develop an easy and quick method for depithing bagasse and to estimate the minimum amount of pith which has to be removed, as well as to study a more suitable pulping method for the Egyptian bagasse, the analysis of which had been found as follows:

Hemicellulose	21.20%
Lignin	18.20%
Methanolbenzene	8.30%
Ash	1.98%

(ii) The results of this investigation showed that only 3% of the prehydrolyzed material is necessary to be removed to reduce the ash content to suitable values. Further removal of the pith had no effect on reducing the ash or increasing the alphacellulose of the obtained pulp. Also, a new method for depithing of bagasse after prehydrolysis was developed and proved to be superior to the depithing before prehydrolysis in being easier, quicker, and leads to pulps higher in yields and with the same alphacellulose and ash content. Besides, it has been proved in this work that suitable viscose pulps can be prepared under atmospheric pressure and without any mechanical stirring by using no more chemicals and pulping times than the conventional prehydrolysis - alkali method under high pressure. The pulps obtained under atmospheric pressure delivered viscose of better filterability than those obtained under high pressure.

(b) Rice straw:

(i) Rice straw is characterized by its high ash and silica content amounting to about 20% and 15% respectively. Nitric acid pulping method, (10,11), applied to rice-straw produced pulps with high ash content ranging from 0.3% to 0.8%. Nevertheless, this process reduced the hemicellulose sufficiently to a value corresponding to that of commercial viscose pulps. Other investigators (12) applied a 2nd stage alkali cook to Egyptian rice-straw at different temperature ranging from 110°C to 170°C and duration between 3 to 4 hours, but pulps obtained were unsuitable for rayon grade.

(ii) The results of research (13) carried at the N.R.C. showed that the high ash content of rice straw pulps is mainly attributed to the leaves. By complete elimination of leaves before prehydrolysis and pulping, bleached pulps with 0.11% ash, and 0.07% silica were obtained. Nevertheless, the leaves constitute about 65% of the raw material difficult to be completely removed mechanically. Most of the ash and silica of leaves are located in the epidermal cells which constitute a small part of the leave structure.

(iii) These cells alone had been removed to a great extent without removing the other unobjectionable leaf cells by screening. This treatment caused a loss of the prehydrolyzed material corresponding to only 12% of the raw material, and resulted in the reduction of the ash and silica of the bleached pulps. Yet, the

ash and silica values were still unsuitable for viscose pulp. By applying moderate pulping conditions, especially short time periods at high temperature to the screened prehydrolysed material, the ash and silica of the pulps decreased and the yield increased considerably. The optimum pulping conditions were 150°C maximum temperature and for a pulping period of 1/4 hour.

(c) Cotton linters:

(i) Egyptian cotton linters had been considered as a possible source for chemical cotton for viscose rayon industry in Egypt. Its high ash content, as shown in Table 2, had proved always to be a major problem.

TABLE II.

CHEMICAL ANALYSIS OF RAW LINTERS

Moisture	%	8.35
Ash	%	3.39
Ash Alkalinity	%	19.69
Nitrogen	%	0.59
Ether extraction	%	1.24
Alcohol-benzene (1-2) extractives	%	1.95
Cold water extractives	%	2.34
Total extractives	%	5.53
Alpha cellulose	%	78.70
Beta and gamma cellulose	%	4.26
Pentosans	%	2.56

(ii) A series of experimental laboratory cooks (14) were made on the Egyptian cotton linters to find a suitable method for preparing purified linters of low ash and silica content, that can be used by the rayon industry. Caustic soda was used as the pulping agent under different conditions of alkali concentration, temperature and time. The unbleached and bleached purified linters were analysed for alpha cellulose, pentosans, extractives, ash and silica. Lowering the ash of the Egyptian linters was accomplished by subjecting the raw linters to a preliminary washing with a suitable commercial detergent followed by alkali digestion and bleaching. This gave satisfactory bleached Egyptian linters analysing:

Alpha cellulose	%	98.65
Pentesans	%	0.93
Extractions	%	0.13
Ash	%	0.09
Silica in ash	%	37.75
and D.P.	%	1519

(iii) Of interest in this study is that the lower alkali concentration was more beneficial in giving the optimum results than the higher and more expensive alkali concentration. The optimum results for alkali digestion for Egyptian linters was found to be 1.5% alkali concentration at 130°C for 6 hours. The final result showed that the Egyptian linters could be considered as a suitable raw material for the production of viscose rayon.

(d) Cotton waste "a" :

Cotton spinning waste is available in a considerable amounts of about 10,000 tons per year. This figure is liable to further increase in the near future as a result of the fast increase in the volume of the cotton spun locally. This fact has drawn attention to this waste as a possible raw material for viscose pulp industry. Laboratory research (15) had been performed and the necessary treatments of the waste before its use had been laid down. Continuous filament rayon yarn was spun on the conventional system and preliminary physical tests showed promising results and render the project worth studying from the economical and industrial aspects.

(e) Eucalyptus wood "b" :

In this study (16) Eucalyptus restrata was investigated as a raw material for production of different grades of viscose pulp. The different pulping and refining processes were tested and good results were obtained.

(f) Reeds (Phragmites Communis):

(i) Chemically suitable viscose pulps were obtained (17) from Egyptian Phragmites communis by prehydrolysis-sulphate-pulping in both the laboratory and the pilot plant. The viscose solution of the phragmites pulp had similar properties as those of the viscose solutions prepared from commercial beechwood viscose pulps of the same disperse viscosity. Spinning trials were made with two different samples of viscose prepared from the experimental pulps. The resultant yarns compared favourably in mechanical and chemical properties with yarns obtained from commercial wood pulps.

(ii) In conclusion it is to be noted, that these researches and others of similar type had been carried out on experimental scale only and its application to industry had been delayed due to lack of pulping facilities particularly on a large scale.

(iii) Nevertheless, as a new factory for paper pulp manufacture is now in action which provides the necessary means for pulping, steps are now being considered to bring the results of these researches to the industrial level. Also, it has to be born in mind, that with the completion of the High Dam project, the quantity of the above mentioned agriculture raw materials will be increased by at least 30%.

IV. LOCAL AVAILABLE RESOURCES OF RAW MATERIAL FOR POLYAMIDES

8. Nylon is manufactured locally at present from imported caprolactam. A project for the production of this imported material

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"a" At the present all cotton waste is consumed in producing condensed yarn.

"b" Eucalyptus wood cannot be considered as a potential raw material unless a scheme for planting forests on a suitable scale is put in action.

is included in the second five year plan. The production will be based on cyclohexane obtained from the proposed project for the petrochemical industry. Enough caprolactam to produce 1750 tons yearly of fiber is scheduled within this project. At the present time, Benzene or phenol will be considered as the starting material for the production either caprolactam for nylon 6 or adipic acid and hexamethylene-diamene for the production of nylon 66. There are several channels which might be utilized for the production of phenol.

(i) Through future expansion of the coking plant which is under construction at Helwan. The production capacity of the plant will be at first 280,000 tons of coke, for the Iron and Steel Factory. The light oil will be a good source for benzene and from it phenol could be prepared. Incidentally we mention that a project for the production of dyestuffs and intermediates and based partly on crudes obtained from the light oil and tar of the above mentioned coking plant has been scheduled in the first five year plan and its erection will start this year.

(ii) Through future developments in the petrochemical industry, the second five year plan made provision for establishing this industry in Egypt which will be based at first on existing light g zoline (120,000 tons). Future developments are possible and the production of benzene from n-hexane or from methyo-cydopentane are possibilities for the future which may lead to nylon 6 or nylon 66 as well as other synthetics such as polyesters "c" and acrylic fibers.

(c) Agriculture waste materials such as corn cobs, wheat-straw or bagasse might be utilized for the production of furfural from which adipic acid and hexamethylene diamine may be synthesized (Nylon 66).

(d) The fourth route which could be utilized is based on acetylene. The production of calcium carbide will take place at Asswan.

V. BLENDS

9. Blends offer innumerable advantages some of which are:

(i) It is an important element in promoting fashion changes as consumers are tempted by the novelty or pleasing appearance of a textile on sale.

(ii) Appropriate blending is an important element in producing fabrics of improved functionability.

(iii) Staple fibers may be blended so that colour effects could be obtained in piece dyeing.

10. Though the statistical data of the amount of man-made fibers used in blends in the UAR is scanty, yet it seems that development in this direction compare favourably with development taking place

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"c" Projects for the production of 350 tons of Polyester and 5000 of acrylic fiber yearly are under consideration. Both fibers will be manufactured from intermediates obtained from the petrochemical industries.

in other countries, consequently increased amounts of man-made fibers are being used each year in producing blends as shown in Table 3.

TABEL III.

CONSUMPTION IN SELECTED BLENDS OF IMPORTED AND LOCALLY PRODUCED MAN-MADE FIBERS

Year	Imported	Locally produced
1959/60	80 tons	1016 tons
1960/61	87 tons	1040 tons

11. Undoubtedly, each producer applies his own efforts for investigations concerning the improvement of the qualities of the fibers he is producing, endeavouring to build up the fiber with optimum properties and maximum value. On the other hand, the blender has to spend more efforts with view of compromising between the different complex factors which govern to a great extent the quality and value of the blended fabric for the different end uses. In the UAR, efforts are being spent on locally produced as well as imported man-made fibers in studying their uses in blends. The following shows a composition of some blend mixtures which were found suitable for the suggested end uses (See Tabe 4).

12. Besides, the expected local production of other man-made fibers in the near future will widen the scope of blends in this country. In particular the production of the artificial wool (acrylic fiber) will provide new material that may partly replace wool as it is most appropriate for our climatic conditions and will be available at comparatively low prices.

13. Also, in addition to the different end uses of nylon staple fibers in other countries, this fiber has found a new market in the UAR, namely the manufacture of press cloth for cotton seed oil production. Usually, this cloth is manufactured from nylon tow and a large number of trials were made to substitute the imported tow by the locally manufactured nylon staple fiber. Also, the 100% nylon carpet is produced successfully in this country to replace the most expensive pure wool carpets.

14. However, the practical difficulties in processing fiber blends are encountered within spinning, preparation and weaving. Difficulties of even more complex nature are faced with in dyeing and finishing. Yet, all these difficulties are more or less associated with the intrinsic fiber properties. In order to achieve any progress in overcoming these difficulties a great deal of research is needed. For this reason as well as solving other problems encountered in the different branches of the textile industry, the need for a textile research institute is most urgent. The foundation stone of this Textile Research Institute will be laid down this year.

TABLE IV

BLENDS AND ITS END USES

Percentage of Fibers in Blend	End - Uses
34% C., 33% V., 33% A. 50% V., 50% A., 67% V., 33% A.	Popular fabrics for summer suitings
35% C., 65% P. 55% P., 45% W. 75% W., 30% A. 65% P., 35% V.	Men's tropical summer suitings
45% W., 40% V., 15% N. 50% W., 50% V.	Popular winter men's suitings
70% V., 30% W.	Ladies' wear
88% W., 12% N. 80% W., 20% N.	Uniform fabrics, socks and pullovers
75% W., 25% N.	Knitting yarn
90% W., 10% V. on woollen system	Ladies' overcoat and suits

C = Cotton A = Acetate W = Wool

V = Viscose P = Polyester N = Nylon

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TABLE (I) IMPORTS, EXPORTS AND LOCAL PRODUCTION OF VISCOSE RAYON AND NYLON AND ITS FUNDAMENTAL RAW MATERIALS
(IN KILOGRAMS)

YEAR	IMPORTS						EXPORTS				LOCAL PRODUCTION			
	CAUSTIC SODA & LYE	WOOD PULP	VISCOSE RAYON			NYLON ARTICLE	CAUSTIC SODA & LYE	VISCOSE RAYON			VIS. RAY.		NYLON	
			YARN & THREAD	STAPLE FIBRE	FABRIC & ARTICLE			YARN & THREAD	STAPLE FIBRE	FABRIC & ARTICLE	CON. FIL. YARN	STAPLE FIBRE	CON. FIL. YARN	STAPLE FIBRE
1950	13913	3437	2472	6056	1237	—	23	—	—	—	1870	1312	—	—
1951	13411	4876	2585	2465	1202	—	5	—	—	—	2315	2200	—	—
1952	14283	4318	1674	595	693	—	3	—	—	—	2299	1699	—	—
1953	13872	5519	2325	419	463	—	2	—	—	—	2540	2570	—	—
1954	17727	6908	1810	837	276	—	5	—	—	—	3433	2963	—	—
1955	24271	8837	1733	833	194	13	—	51	—	—	4592	3590	—	—
1956	21848	9217	1771	646	107	14	—	60	—	1699	5087	3447	—	—
1957	38035	9656	359	507	40	2	—	96	—	1040	5492	3449	—	—
1958	19385	10578	217	229	26	—	—	74	—	702	5692	4084	34	101
1959	32038	12097	153	358	19	—	—	384	—	1163	6081	5120	53	119
1960	36118	11928	167	730	22	—	—	269	—	1312	6610	4434	61	181
1961	28613	11979	29	577	5	—	—	431	—	1024	6749	4343	175	144

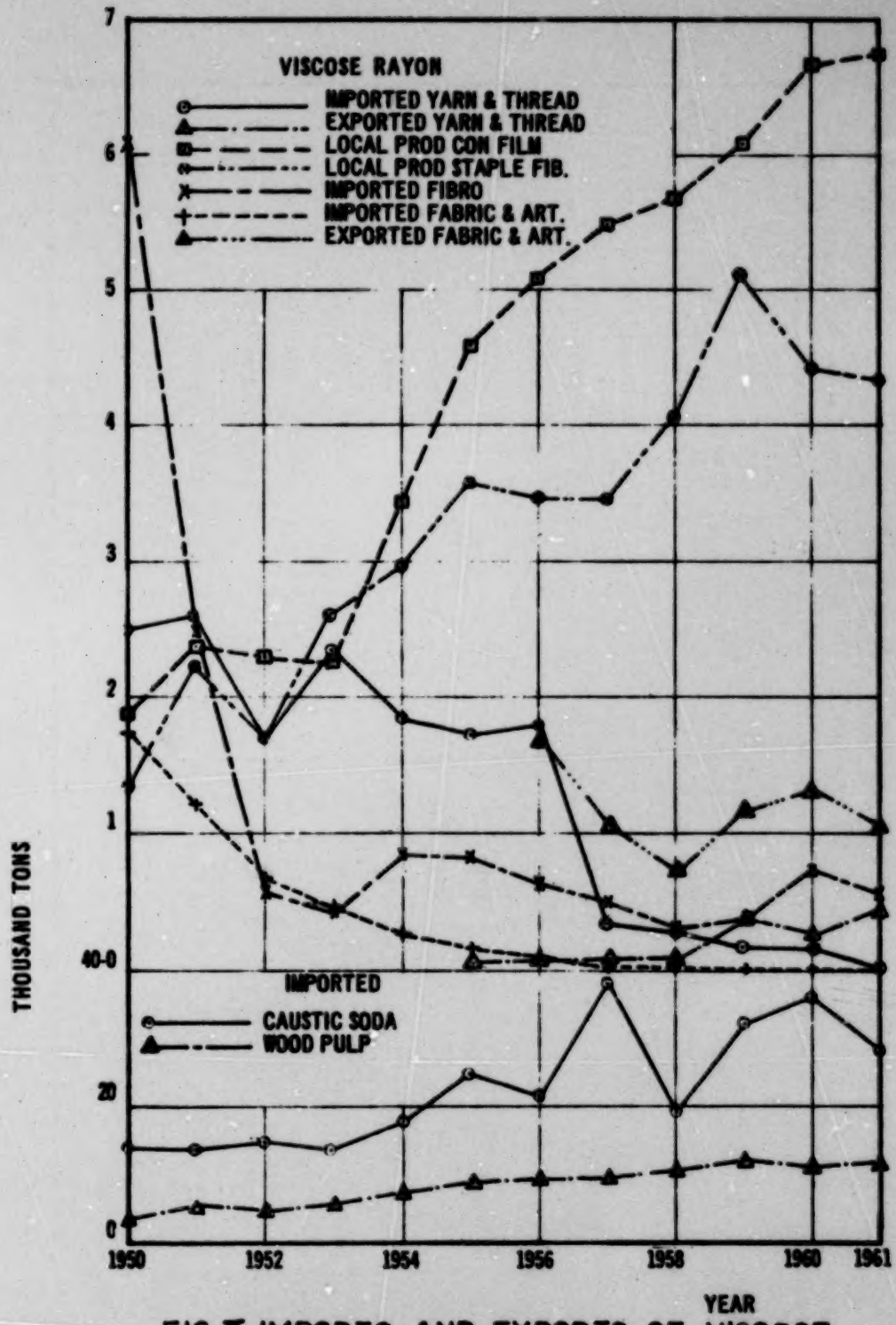

FIG. I IMPORTS AND EXPORTS OF VISCOSE RAYON AND RAW MATERIALS

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SUMMARY

Agenda Item: D.6.1. United Arab Republic

POSSIBILITIES OF PRODUCING VISCOSE, RAYON AND NYLON FROM AVAILABLE LOCAL RAW MATERIALS AND BLENDS WITH NATURAL FIBRES

By H.M. EL-BEHERY, Ph.D.,
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No. 418 POSSIBILITIES OF PRODUCING VISCOSE
D.6.1. RAYON AND NYLON FROM AVAILABLE LOCAL RAW MATERIALS AND BLENDS WITH NATURAL FIBRES

H. M. El-Behery, Ph.D.*

Faculty of Engineering, Alexandria University

SUMMARY

The manufacture of man-made fibers started in the UAR in 1950 with the production of viscose rayon filaments. At the present the total production amounted to 6749 tons of continuous filament rayon and 4343 tons of staple fiber. In 1957 exportation started and increased year by year till it amounted in 1961 to 23% of the total production of filament yarn, 11.2% of viscose staple and 17.4% in cloth form.

Practically all the chemicals utilized in produced viscose rayon are manufactured locally with exception of cellulose wood pulp which is still imported. To render the industry self-independent, a study of the available agricultural waste products which could be used for production of cellulose pulp suitable for viscose production was carried out by the National Research Centre of the Republic, on the following:

a) Bagasse
b) Rice-straw
c) Cotton linters
d) Cotton waste
e) Eucalyptus wood
f) Reeds (Phragmites Communis)

Bagasse: The main results of research on bagasse showed that only 3% of the prohydrolyzed material has to be removed so as to reduce the ash content to suitable values and further removal of pith had no effect in reducing the ash or increasing the alpha-cellulose. In fact a suitable technique for the preparation of cellulose pulp of the required specification was worked out on a laboratory scale.

Rice straw: Rice straw is available in very large quantities but this straw is characterized by its high ash and silica contents amounting to about 20% and 15% respectively. Chemists of the National Research Centre found out that most of the ash and silica of the straw is attributed to the leaves and that most of it is located in the epidermal cells which constituted a small part of the leave structure. These cells alone had to be removed. By applying moderate pulping conditions especially for short periods at high temperature to the screened prehydrolyzed material the ash and silica of the pulps decreased and the yield increased considerably. The optimum pulping conditions were 150°C maximum temperature and for a pulping period of 1/4 hour.

Cotton linters:

Egyptian cotton linters were found to contain a high ash content of about 3.39%. Researches carried out showed that if the raw linters were subjected to a preliminary washing with a suitable synthetic detergent followed by an alkali digestion and blesching, the ash content will drop to 0.09%, the silica content of which amounts to 37.75%.

The optimum/for alkali digestion of the linters was found to be 1.5% alkali concentration at 130°C for 6 hours.

Cotton waste:

At the present the cotton spinning waste amounts to about

*In collaboration with: S.T. El-Serafi and A.K. Wahbi

10,000 tons per year. The purified material was used for the production of continuous filament rayon yarn and preliminary physical tests showed promising results and render the problem worth studying from the economical and industrial aspects. At the present most of this waste is used in producing condensed yarn.

Eucalyptus:

Eucalyptus rostrata was investigated as a raw material for production of a suitable viscose pulp. Although good results were obtained, eucalyptus cannot be considered a suitable raw material unless steps are taken to plant forests of suitable area to supply the needed wood.

Reeds (Phragmites Communis):

Chemically suitable viscose pulps were obtained from Egyptian Phragmi. Communis by prohydrolysis-sulphate pulping process. The resulting viscose yarn obtained from this pulp compared favourably in mechanical and chemical properties with commercial wood pulp.

It is to be noted that these researches have been carried out on a laboratory scale, steps are now being taken to bring the results of these researches to the industrial level. The test will be carried out in the new factory for paper pulp manufacture at Alexandria.

Manufacture of Polyamides and other synthetic fibers:

NYLON (6) is manufactured locally at the present from imported caprolactam. Enough caprolactam to produce 1750 tons yearly of Nylon 6 fiber is scheduled within the petrochemical industry project. The production of benzene from N-Hexane or from methycyclopentane are possobilities which may lead to nylon 6 or nylon 66.
Projects for the production of 350 tons of dacron and 5000 tons of acrylate fiber yearly are under consideration. Both fibers will be manufactured from intermediates obtained from the petrochemical industry.

On the other hand agriculture waste products such as corn cobs, wheat straw, bagasse, etc... might be utilized for the production of furfural from which adipic acid and hexamethynene diamine may be synthesized for the production of Nylon 66.

Blends:

Fibers may be blended for several reasons among which the following may be mentioned:

a) It is an important element in promoting fashion changes as consumers are tempted by the novelty or pleasant appearance of a textile on scale.

b) Blending is an important factor in producing fabrics of improved functionability.

c) Staple fibers may be blended so that colour effects may be obtained in dyeing.

In the UAR blends of man-made fibers with each other or with natural fibers as shown in Table 3 is increasing slowly but steadily and there is no doubt that blenders will play an important role in the world of textiles in the near future.

Yet their use will raise difficulties in spinning, weaving, dyeing and finishing. These difficulties will be tackled and solved in the new textile research centre, the foundation stone of which will be laid this year at Alexandria.

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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : D. 5

United Arab Republic

PRODUCTS OF ANIMAL AND PLANT ORIGIN AND SUBSTITUTES

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PRODUCTS OF ANIMAL AND PLANT ORIGIN AND SUBSTITUTES

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INTRODUCTION

1. The present paper deals with some essential aspects of the utilization of some vegetable and animal substances in UAR, in the production of some edible oils, corn-starch and sugar industries. Some problems concerning these industries will also be briefly discussed.

PART I

EDIBLE OILS

2. Fats and oils play an important part in Nature's scheme to support and sustain life. Many of them have yet no commercial significance, others are of purely local importance.

3. In the UAR, the cottonseed is the main source of oil industry. The amount of oils extracted from cotton and other seeds is about 91,000 tons every year, that of cottonseed oil produced locally is 89,200 tons. Cottonseed kernels, the source of the oil, contain a strong deep brown colouring matter, and the crude oil escaping from the press has a ruby-red colour which is so intense that it appears sometimes to be nearly black. The oil is refined and decolourized by submitting it to a partial saponification by heating with a solution of caustic soda of suitable concentration. A sort of defection occurs and the soap which is formed carries away the colouring matter. In this connection three types of cottonseed oil are produced by the Egyptian industry. The "English" oil is produced by heating the crude oil with caustic soda solution. This type of oil accounts for more than 80% of the production and is used for edible purposes and for the manufacture of soap. After further refining by decolorising and deodorising the golden yellow oil is sold under the trade name "Sultane", and is utilized exclusively for edible purposes. The third type, known as "French Oil", is a completely refined product destearinised by a process of refrigeration and filtration.

4. The object of refining and bleaching is to remove the objectionable impurities in the oil with the least possible damage to the glycerides or to the tocopherols or other anti-oxidants. Crude cottonseed oil, as reported by Jamieson & Baughman (1),

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(1) Jamieson, O.S., & Baughman, W.F., 1920: Cotton Oil Press, 4, No.3, 61-3.

contains the following constituents: raffinose, pentosans, resins, proteoses, peptones, phosphatides, phytosterols, inositol phosphate, xanthophyl and free fatty acids.

5. The laboratory refining loss test of cottonseed oil does not reveal how much refined oil will be yielded by the crude oil when the latter is actually processed in the refinery. In addition to free fatty acids, carbohydrates and the above mentioned constituents of the crude oil are also removed by refining, and there is invariably lost, through saponification and emulsification, a certain amount of neutral oil. This amount changes according to the variability of the surface-active properties of some of the non-glycerine constituents. Likewise crude oil with similar contents of free fatty acids and total nonoil substances may yield refined oils with different depths of colour. A true indication of the value of the crude products can, therefore, be obtained only by means of small scale refining tests.

6. In this connection, the editor (2), studying the effect of hot-air treatment of cottonseed as it is followed in the UAR, has noticed that it had a slight effect upon some of the properties of oil, although the acid value was slightly higher in the oil extracted from the treated seed. The editor (3) also studied the effect of different refining treatments on the yield of the crude oil as well as the various physical and chemical constants of the oil extracted from Egyptian cottonseeds representing the important strains of cotton (Ashmouni, Karnak and Menufi). All the seeds had been treated previously by hot air as requested by law. The seeds of each variety in the first group were crushed separately, then air-dried at 105° for one hour to determine the oil content, other samples of each variety were crushed, then cooked with steam at 92°C. and then pressed hydraulically at 4480 lb/sq. in.

7. Physical and chemical constants were determined in the crude oil of each variety. In the second group the percentage of the dead seeds (red seeds) was determined by calculation; according to the dead seed content and the acid value of each variety of oil, a mixture was made from the seeds of the three varieties in the proportion 50:25:25 for Ashmuni, Karnak and Menufi respectively. The mixed seeds were crushed as received without removing the fibres and then cooked with steam as mentioned before. The crude oil was allowed to settle at room temperature for 24 hours, and acidity was determined and found to be 2.584 as oleic acid. Accordingly the required amount of alkali for neutralization was calculated (16.5ml NaOH, 16Bé) for each 500gm of crude oil. However, neutralization was carried out in three steps, the resulting refined oil represents three kinds of the grade "English" or "No.3" oil as is known in commerce:

English I, 16.5ml NaOH (100% of calculated required amount)
English II, 12.4ml NaOH (75% " " ")
English III, 20.6ml NaOH (125% " " ")

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(2) Kamal, M.A.M., Ann. Agr. Sc. Fac. Agr., Ain Shams Univ. Cairo Vol.3 No.3 (1958)
(3) Kamal, M.A.M., Ibid, Vol.2 No.1 (1957).

Each amount of caustic soda was added to 500Gm of the crude oil, stirred at 40°C for 20 minutes at 70 rpm, and then filtered with filter paper. No washing was used to avoid gain of moisture and to enable further determination. The weight of the soapstock (mucilage) was determined and accordingly the refining loss per cent was calculated. Each kind of the refined (English) oil was bleached by heating 100Gm of the oil at 90°C, adding 2% of its weight Fuller's earth, then stirring at constant temperature for 15 minutes at 120 rpm, and then filtering with filter paper. The resulting three kinds of oil; Bleached I, Bleached II, Bleached III, represent the oil grade known in commerce as No. 2 Oil. No deodorization was used in order to enable further determination of the iodine value.

8. The results showed that the dead seeds have a lower oil content with higher acid value than alive seeds. It should be stated here that the cottonseed grade is usually evaluated according to the percentage of red (dead) seeds present in each sample. The seeds under investigation contained 9.28, 14.89, 21.20% of dead seeds for the varieties Ashmuni, Karnak and Menoufi, respectively.

9. Investigated cottonseed lots differed mainly in their oil content and the acid value of the crude oil. Ashmuni seeds had the highest oil content (24.6%) with the lowest free fatty acids (1.724 as oleic), while Menufi seeds had the lowest oil content (20.1%) with the highest acid value (4.204 as oleic). This may be attributed to the variations in the dead seed content in each variety lot. Slight acidity was found in all kinds of refined oil, although the acid value decreased considerably when the amount of caustic soda used for neutralization was 125%. This may be due to the partial hydrolysis of the glycerides caused by the rise of temperature or by the uptake of some of the alkali in partial saponification.

10. The effect of bleaching revealed a very slight increase in acidity, and this may be due to the acidic effect of Fuller's earth used. It is interesting to mention that a consistent relationship between free fatty acids and the average refining loss was noticed, and this relationship was conversed when the amount of NaOH used for neutralization was increased.

11. With regards to the constants of the oil it was noticed that iodine value and refractive index were not influenced by the different refining levels of NaOH, and the value of these constants, however, in the three levels of bleached oil was lower than in the three levels of English oil of the same sample. Saponification value did not show any variation during the different refining treatments, and the unsaponifiable matter in different grades of oil ranged from 1.3 to 1.8. No clear effect was noticed due to the effect of refining treatments.

12. The amount of oil produced from oleaginous seeds and its constituents are largely affected by the method employed in extraction. The mechanical methods which involve the use of hydraulic pressure usually produce a low yield of oil. There is a great

number of solvents that could be used for extracting oily materials, and it is obvious that the degree of extraction depends largely on the nature of the solvent and the temperature employed during this process.

13. Work on this problem, by the editor, using cottonseed oil (Karnak and Ashmuni varieties) showed that the amounts of oil extracted with different solvents were not similar. Carbon disulphide and petroleum ether, exhibited the same extraction power with cotton seed. In general the solvent extraction process showed its superiority over the hydraulic pressure method. The quantity of the unrecovered oil by the hydraulic pressure method in terms of percentage of the total oil increased progressively as the oil content of the seed decreased. The loss in the yield in cotton seed varieties ranged between 22.1% and 24.3%, for Karnak and Ashmuni respectively.

14. With regards to the various constants of the oils under investigation it was noticed that the specific gravity and the refractive index of oils produced by means of solvents were lower than those values reported for oil produced by the mechanical press. Petroleum ether and carbon disulphide produced oils with a low iodine value. This emphasises the fact that the unsaturated fatty acids in the glycerides of cotton seed oil are quite different from those of olive oil. It may be worth mentioning that the data on cottonseed oil revealed that the acid value of the oil produced by mechanical pressure was higher than that extracted with solvents. Hexane gave the lowest free fatty acid content among the other solvents. This leads to the impression that hexane is regarded as the best solvent for the production of oil with the lowest possible acidity as far as this investigation is concerned.

15. In this connection it should be mentioned that the crude oil content of the different varieties of Egyptian cotton seeds ranges from 24.41 to 27.61%, calculated as percent of dry matter and as determined in the hulled seeds. It is worth noting that the oil content appeared to be mostly an inherited property of the variety.(4) It seems also that the varieties of Ashmuni type (short-stapled cotton seed) possessed the highest oil content among the other types grown in the UAR. Since the average apparent local consumption of oils and their products amounts to 125,000 tons, it appears that there is a lack in local oil production amounting to 34,000 tons. Therefore it was necessary to search for new oily seeds or new oily sources and to improve the methods of extraction in oder to help supply the oil production and industry in the UAR.

RICE BRAN- and CORN-OILS

16. The oil produced from some cereals and other oleagenous kernels such as sesame, sunflower, peanuts, and prickly lettuce will offer an excellent solution to help supply for oil production in the UAR and other countries.

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(4) The editor: Kemal, M.A.M., Ann. Agri. Sc. Ain Shams Univ., Cairo, Vol.3, No.2.

17. The annual world production of rice is about 200 million tons. The total consumption of rice in the UAR is nearly 682,000 tons of milled rice coming from 991,000 tons of paddy, taking into consideration that the milling extraction factor for rice is about 66%. Two varieties of rice are cultured in the UAR, the long-grain and the short-grain.

18. Rice barn, the by-product of rice milling, amounts, in the UAR, to 90,000 tons, produced annually from 64 mills. The short-grain rice variety contains a high amount of bran, 7.5% while the long-grain variety contains about 5.9%, and the oil content of bran ranges from 13.12 to 18.03%. It was found that bran from short-grain rice has a comparatively higher oil content.

19. Generally speaking the oil in bran is 12%, and in the embryo about 13%; both percentages are approximately 2% less than the American rice bran. The crude rice bran oil contains 10.5% waxy substances. The extracted oil showed the following characteristics (5): Sp. Gr. 0.9289 (d 30°), Ref Index 1.4696 acid value 17.24, Sap. value 18.3, Iodine value 93.60, and the rice bran consists mainly of 48.36% oleic, 27.60, and the rice bran consists mainly of 48.36% oleic, 27.64% Linoleic and 19.44% saturated fatty acids.

20. The rice bran oil is produced by the solvent extraction method. The extraction of the oil by commercial hexane followed two rates, 50% of the oil content was extracted by the first rate (diffusion) in a few minutes (5-10 min), and the second rate (dialysis) is comparatively slow. The lower alcohols are better than hydrocarbons and 2-propanol is preferable to ethanol for its miscibility with rice bran oil.

21. The main problem with extracting oil from rice bran is that fatty acids form quickly on separation of the bran from rice bran is that fatty acids form quickly on separation of the bran from the rice grains, and oxidative rancidity is also taking place. This could be overcome by heating the bran to near dryness to hinder the enzymatic activity. In this connection the rice husk could be used as a fuel for this purpose. So, we suggest that drying ovens must be placed near or inside the mills.

22. Well stored bran should contain only 3-5% of humidity. The expenses of this procedure can be solved in UAR by raising the price of milled rice from 39 to 40 mills.

23. In this connection, the effect of steaming fresh paddy rice on the development of free fatty acids during storage of brown rice has been studied by several workers (6). Enzyme inactivation appeared essentially complete after steaming. The use of par-boiled rice, also, offered advantages for studying the processes of deterioration in cured grains. It is worth

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(5) Hinnawy, S.I., Ph.D. thesis, Ain Shams Univ., Cairo (1957)
(6) Houston, D.F.; Hunter, J.R. & Kester, E.B., Cereal Chemistry, 394 (1951).

to mention that the par-boiling process is about to be introduced in the UAR. In July 1963 the first par-boiling factory will be finished, at Mehalla, and its annual capacity will be 20,000 tons of paddy. Another factory is to be built, and it will export to Ceylon about 50,000 tons every year (L. 34 per ton).

Corn Oil

24. Maize- or corn-oil is obtained only from the germ (scutellum) which is commercially separated from the endosperm by several processes before pressing. The oil content of the whole fruit ranges 3-5½ %. It was found that the oil content in some different varieties and strains, grown in the UAR, ranges from 4.79-6.38%, and the amount of oil seems to bear some relation to the weight of seeds. Reports from the Ministry of Agriculture indicate that the oil content of corn kernels is higher in the open pollenated varieties than in those produced from double crossing.

25. Corn oil is produced as a by-product in factories making starch from maize. In this connection it should be mentioned that the cultured area of maize in the UAR is 1,850,000 feddans, which produce about 1,499,000 tons of maize, with an average of 88 tons per feddan. All these amounts are consumed in knead making and materials other than starch and its products. Thus, the starch industry from corn, i.e. the corn oil production, in the UAR depends only upon imported corn. There are three factories in the UAR specialised in starch industry from corn. The largest factory (Sirpakis) produces 45 tons daily of glucose syrup, 10 tons of starch, 4 of oil, 25 tons of feed and 7 tons of cake. The corn needed for this factory, at the present time, is about 60,000 tons of imported corn, and this quantity is about half the actual production capacity. The tone of crude oil is sold for about L.E. 120, but the pure oil is sold for about L.E. 400 per ton.

26. The keeping qualities of this oil are fairly good, but the crude oil is easily hydrolysed if meal is present. The iodine value of corn oil ranges from 110-125, the saponifcation value is about 190 and the free fatty acids (so oleic) about 3%. It contains about 0.9 - 2% unsaponifiable matter. In the UAR corn oil is expensive because of the shortage in corn quantities available for starch industry. In this connection researches are being carried out, in the UAR, concerning the use in medical purposes, so that it is still sold only in pharmacies. Thus it is of great importance to increase the cultivated area of corn in the UAR, or to cultivate other suitable oleagenous crops.

Other Sources of Edible Oil

27. Attention should be paid to sunflower seed production; it is considered as one of the best sources of oil as well as animal feed. The editor showed that the sunflower varieties cultivated in his experiment (7) yielded from 720, to 916 Kgm. seeds per feddan, with crude oil contents 26.74, to 29.15%,

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(7) Kamal, M.A.M. & Damaty, Ann. Agric. Sci. Fac. Agric., Ain Shams Univ., Cairo, Vol.II, No.1 (1957).

The average oil content of the different varieties of pure strains of Egyptian cottonseed was lower by 2% than the average oil content of sunflower seed and by 6-8% than the commercial grades of conttonseed. The editor also noticed that the crude filtered oil of sunflower seed varieties under investigation contained a very little amount of free fatty acids, and the crude filtered oil, obtained by the mechanical press, of the different varieties of sunflower seed is as very clear, had a bright yellowish colouration and was characterized by its good flavour and odour. It was also noticed during this study that no further acidity occurred owing to the ageing of the crude filtered oil. This is of great importance from the economical point of view.

28. It is interesting to mention that the Ancient Egyptians cultured an important oily crop which is known as Lactuca scanola (prickly lettuce). There is no doubt that the varieties growing now in the UAR originated from the ancient varieties, and it is only cultivated in Upper Egypt near Kena and Asswan. Although the nutritive value and oil content of the seeds of this crop are undoubtedly high, yet the cultivated area in the UAR is very small and does not exceed 1000 feddans. This oil is used in those regions as butter or "Samna" substitute, and it is known as "Sweet Oil" or "Oil of Cows". All kinds of soil are suitable for the cultivation of this crop, and it is cultivated either alone of mixed with other leguminous crops. The yield of oil varies widely with the type of soil. In the UAR it is cultivated in November and harvested after almost six months. The feddan yields about 600 Kgm of seed. Preliminary studies carried out by the editor showed that the oil content of some black-seed varieties is about 49% of crude oil. In general the oil content ranged from 30-38%. This wide range is due to the effect of variety and type of soil and locations. The average values of some physical and chemical constants of the varieties of prickly lettuce seed oil, investigated by the editor and co-workers, are: Sp.Gr. 0.9377, ref. ind. 1.4733, sap. value 190 and iodine value 129. The leaves of the crop, and cake of seeds, after oil extraction, are used for animal feeding in UAR. It is interesting to note that this crop is irrigated only once throughout the whole season of growth; this is of great importance to pay attention to such inexpensive oily crops.

PART II

CARBOHYDRATE INDUSTRIES IN THE UAR

Some Problems in the Manufacture of Sugar Cane and its Products.

29. Sugar cane is an important agricultural crop in the UAR, also it is the principal crop in Kena and Asswan as well as some parts of Menya and Assyout. Sugar manufacture is a successful national industry because it is a major consumer product. The average per capita consumption of sugar in the UAR is 14-15 Kgm. per year; this is covered by the local plantations.

30. Statistics for the year 1961 show that the total area under sugar cane was 85140 feddans; the average crop per feddan was 43290Kgm; the amount used up by the sugar industry was 3531581 tons; the amount of sugar produced was 363028 tons. New planning was put to make use of as much as possible of the land that

will be irrigated by the High Asswan Dam in the production of cane, to increase the capacities of the 4 factories already present in Kom Ombo, Armant, Nag Hamadi and Abu Korkas and to build 4 new ones in Edfu, Kous, Kena, and Baliana so that the UAR would become a sugar exporting country. Since 1952 the area of land planted with sugar increased from 64248 to 85140 feddans, cane yield per feddan increased from 32.3 to 41.3 tons, and the average sugar yield per feddan increased 2.94 to 4.25.

31. In UAR by-products of sugar industry are utilized in producing ethyl alcohol, vinegar, glacial acetic acid, perfumes and cosmetics. New industries arising are dry yeast and pressed wood manufactures.

32. The problems encountered in the manufacture of sugar in the UAR are the following:

(a) Improving the present species or finding others known to have a high sucorse content and a low fibre content.

(b) Increasing the tonnage per feddan by improving agricultural treatment of the land, especially by the use of fertilizers.

(c) Increasing the sugar yield per feddan. This can be achieved by not leaving the cane to over-mature in the soil, and by harvesting it at the proper time in order to avoid the inversion of sucrose into non-crystallisable reducing sugars which are of no use to the industry.

(d) Early delivery of the cane to the factory after harvesting. If left for more than one day, before delivery, inversion of sucrose will occur.

(e) In the UAR cane is grown by budding. This leads to gradual deterioration of the species in the following years. The Ministry of Agriculture is attempting to encourage cane, grown in special greenhouses, to flower and to produce seeds, by supplying optimum of temperature and humidity.

(f) A problem which has been solved in the UAR is that of choosing the most representative joint stalk for analytical purposes. This has been found to be the fifth or sixth joint from the top of the stalk.

33. The analysis of the juice obtained by a three roller mill is as follows: total solids 21%, sucrose 12.93%, reducing sugars 1.54%, ash 37%, albuminoids 18%, free acids 0.1%, combined acids 14%, gums 0.1%. The commercial sugar contains 0.07% reducing sugars, 11.0% ash, water 0.7%, organic matter 0.03% with 99.75 polarisation.

34. Molasses which results from sugar manufacture is used for many purposes: manufacture of all kinds of distillates, production of chemicals such as acetic acid and potassium salts, as well as a food-stuff. The composition of molasses is as follows: Total solids 90.5%, water 9.5%, sucrose 39.4%, reducing sugars 14.3%, and organic matter 27.3%. Researches are carried out

concerning the use of cane molasses in the industry of citric and itaconic acids, and of antibiotics using microbiological methods (8).

Other Sources of Sugar

35. It is necessary to introduce new sugar-containing plants, other than cane, in order to boost sugar production in the UAR. Reports on the preliminary experiments carried out by the Egyptian Ministry of Agriculture in 1959 indicated that sugar beet could be successfully grown in sandy and saline soils, whereas sugar cane, under the same conditions, is practically unable to develop to its normal growth. In addition it is well known that the sucrose content of sugar beet roots is about 17% of the fresh weight, while the figure for sugar cane is about 12%; similarly the ratio of extraction of sucrose from sugar beet is higher than that for cane. This is due to the difference in the method of sucrose extraction from each.

36. Experiments were carried out to investigate the effect of fertilizer treatments on the growth and carbohydrate fractions of sugar beetroot plant grown in sand cultures. Results concerning the weight of beet root and sucrose content in the final stages of growth revealed that roots grown under favourable conditions of Potassium levels (18 mlEq) showed maximal growth (569 Gm per root) with the highest sucrose content of 19.56%. It is worth mentioning that beet root is cultivated twice a year, in June and October, and that the average yield per feddan per crop is 15 tons, i.e. 30 tons could be obtained from one feddan in one year. The cane crop which occupies the land for about one year yields about 30 tons of cane with a sucrose content of 12%.

CORN STARCH INDUSTRY IN THE UAR

37. Corn starch is the principal industrial starch in the U.S.A.,,which is considered as the largest producer of corn starch. Nearly 210 billion pounds of corn are produced annually in the U.S.A., and about 3% of this is milled to make starch and products derived therefrom. Starch per se comprises half of the milled quantity while the other half is used for making sugars, syrups and dextrins.

38. In the UAR the area cultivated for corn production is about 1,850,000 feddans, and the annual production is about 1,499,000 tons, (88 tons per feddan). All these quantities are consumed for bread making, especially in the village. Thus, corn starch production, in the UAR, depends mainly on imported corn. About 70,000 tons of corn are imported every year. This quantity does not cover the actual need for complete production capacity of corn starch in our factories. In this connection it should be mentioned that there are six factories for starch production in the UAR. Three are concerned with corn starch production; one of them uses sweet potatoes as a source of

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(8) Shimi, I.R., Faculty of Science, Ain Shams University, Cairo

starch. The other two use rice for starch production. The most important corn starch producer is the National Starch Industry Co. (Syrpakis). The actual production of this factory 8,800 tons of starch and 26,000 tons of glucose syrup annually. The daily production of this factory of corn products is as follows: 45 tons of glucose syrup, 10 tons of starch, 4 tons of oil, 25 tons of feed and 7 tons of cake. The amount of imported corn consumed by this factory is about 34,675 tons, while the amount required for full production capacity is 60,000 tons at the present time.

39. As metioned before, the starch industry in the UAR depends mainly on imported corn, and to solve the problem the cultivated area of corn in the UAR, must be increased, and species and hybrids that yield abundantly should be selected. Another suggestion is to replace corn, as a main food-stuff, with another crop beside increasing the imported quantities, for the time being, and giving the facilities from exporting countries to the UAR to fulfill its production of corn starch. Another difficulty which we are meeting is the machinery and spare parts. The UAR, if provided with machines and spare parts, either imported or locally produced, will surely increase its yield of starch.

40. As mentioned before in "Corn Oil Production", the corn starch is produced, in the UAR, by the sulphur dioxide method. It is an essential rule in the manufacture of starch to replace the associated nitrogenous substances quickly, by centrifugal methods, to prevent the change which happens owing to fermentation or acid formation. The protein matter, or gluten, amounts to 8-10% and consists of water-soluble albumens, soluble globulins, protamines and alkali-soluble gluteline. Most of them could be separated as the substantially water-insoluble gluten, but soluble globulins and albumens are removed from the corn when it is steeped at the beginning of the process. This steeping water also contains soluble salts which form some 33% of the solid matter removed at this stage. The water soluble extract of corn grain has a pH value of approximately 6.0-6.5. About one third of the dry substance is composed of low molecular weight carbohydrates. These may be fermented by bacteria associated with the grain when it is steeped in the warm acidulated water used in early stages of wet milling. The chief product of fermentation at the temperature employed is lactic acid. The acids tend to hydrate the protein of the grain and to solubilise the alkaline earth salts. The phytates may be split into phosphates and inositol, and the proteins into the usual degradation products: peptones, amino acids and ammonia (cf. Kerr, 1950: Chem? & Industry of Starch) Thus the steep liquor of corn in starch industry is of valuable biochemical values. Further study and investigation concerning the biochemstry of steeping liquor is being carried out (9).

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(9) Kamal, M.A.M., and Shimy, I.R.

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SUMMARY

Agenda Item: D.5.

United Arab Republic

PRODUCTS OF ANIMAL AND PLANT ORIGIN AND SUBSTITUTES

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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PRODUCTS OF ANIMAL AND PLANT ORIGIN AND SUBSTITUTES

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SUMMARY

EDIBLE OILS

1. Cottonseed Oil: About 89,000 tons of cottonseed oil are produced locally every year. Oil content of Egyptian cotton seed ranges between 24.4 and 27.6%; it appeared to be an inherited property of the variety. Ashmuni type seeds have the highest oil content. Lots of mixed varieties of seed used vary in their content according to variation in their dead seed content. Dead seeds have a lower oil content with a high acid value. Mechanical methods give a low yield of oil; loss in yield is 22% - 24.3%, according to variety. This could be recovered if solvent extraction methods are used. Hexane is the best solvent tried for oil extraction. Oil extracted with solvents if generally of lower acidity than that produced by mechanical press. The effect of bleaching on oil (during refining) revealed slight increase in acidity. A consistent relation between free fatty acids and average refining loss was noticed; this relation was conversed when the amount of NaOH, used for neutralization, was increased.

2. Rice Bran and Corn Oils: Annual rice bran production in UAR is 90,000 tons. Oil content of bran varies from 13.12 - 18.03% according to variety. Oil extracted with commercial hexane followed two rates. Lower alcohols are better than hydrocarbons. The main problem with extracting oil from rice bran is the quick formation of fatty acids and oxidative rancidity. This could be inhibited by drying bran in ovens which must be placed inside or near the mills. Effect of steaming and parboiling of paddy on the quality of rice bran should be investigated further. Other treatments should be tried.

3. Corn oil production depends on imported corn which is the only source for corn starch industry in UAR. To solve this problem the cultivated area of corn must be increased, or corn replaced as a main foodstuff with other crops, in the meantime increasing quantity of imported corn. Corn oil is obtained from the germ of the kernel. Oil content of whole fruit is 4.79 - 6.38% in varieties cultivated in UAR.

4. Other Sources of Edible Oils: Attention should be paid to sunflower seed and prickly lettuce seed production in UAR and other countries.

CARBOHYDRATE INDUSTRIES IN UAR

5. Cane Sugar and its Products: Average per capita consumption of sugar in UAR is 14-15 Kgm per year; this is covered by local production. Total area under sugar cane is 85140 feddans with average yield 43290 Kgm of cane per feddan. Present four factories produce 363,028 tons of sugar per year. Recent projects made to increase capacities of present factories and to erect new ones. Also land irrigated by High Asswan Dam will be used for cane production. Trials made to introduce cultivation of beet root as a source of sugar. Problems encountered in manufacture of sugar are:

(i) Cane is grown by budding which deteriorates the species; this necessitates import of new species and better agricultural treatment of soil.

(ii) Not leaving cane to over-mature and its early delivery to the factory to avoid inversion of sucrose.

6. It was found that the 5th or 6th joint from the top of the stalk is the most representative for analytical purposes. Ethanol, vinegar, acetic acid, perfumes and cosmetics are produced from by-products of cane sugar industry. Molasses is used for the manufacture of many chemicals.

7. Corn Starch: The annual production of corn in UAR, 1,499 tons, is totally consumed for bread making in the villages. Starch industry depends on imported corn. There are six starch factories, three of them use corn for starch production and they run at half capacity because of shortage of imported corn and of machinery and spare parts. The sulphur dioxide method is used in UAR for corn starch production. The daily production of one factory is: 45 tons glucose syrup, 10 tons starch, 25 tons feed and 7 tons cake, and 4 tons oil. The steep liquour of corn is under investigation to make use of its nutritive value.

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Agenda Item: D. 11

United Arab Republic

THE FERTILIZER INDUSTRY IN THE UAR : FACTORS DETERMINING THE CHOICE OF RAW MATERIALS AND PROCESSES

By Mohamed el HALFAWY, Ph. D.,
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Department of Industrial Planning

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Fertilizer Plant, Helwan

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D.11

THE FERTILIZER INDUSTRY IN THE U.A.R.

Factors Determining the Choice of Raw Materials and Processes

By

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And

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Formerly, Director, Fertilizer Plant, Helwan

Introduction

1. The prime resource of the U.A.R. is its fertile agricultural land. The land under cultivation amounts to about 6 million feddans and through perennial irrigation is the equivalent of 10.3 million feddans of crop yields. U.A.R. agriculture is dependent on relatively heavy use of fertilizer to maintain crop yields. In 1952 for example, the country consumed about 600,000 metric tons of imported nitrogen fertilizer (based on 15.5%N) in addition to about 110,000 tons locally produced. The consumption has, since then, steadily increased, e.g. in 1961 it amounted to 1,232,000 tons. Superphosphate consumption amounted to about 110,000 tons in 1952, most of which was locally produced, but in 1961 the consumption increased to about 300,000 tons.

2. The domestic fertilizer industry has grown very rapidly since the 1952 revolution. This rapid growth springs not only from a basic desire to become self-sustaining but also from a desire to increase the productivity of the land.

3. The only nitrogen fertilizer plant before 1952 was erected in Suez in 1949 with an annual production capacity of 200,000 tons of calcium nitrate (15.5%N), although the actual production was only 110,000 tons in 1952. Superphosphate was produced by

two factories, one in the Delta area (annual capacity 65,000 tons, erected 1937) and the other in the Cairo area (annual capacity 35,000 tons, erected 1948).

The First Five Year Plan

4. Early in 1957 the Ministry of Industry, submitted to the nation its first five-year plan. In this plan special attention was given to the development of the nitrogen fertilizer industry. The plan included three projects, viz.,

(a) the erection of a new plant in Aswan for the production of ammonium nitrate with an annual capacity of about 530,000 tons calcium ammonium nitrate (20.5%N) .

(b) the extension of the Suez plant from 200,000 tons to 250,000 tons/year of calcium nitrate.

(c) the erection of a new unit in the Suez plant for the production of 100,000 tons of ammonium sulphate per year (20,5%N) .

The first two projects have already started production during 1960 while the third project has just started.

5. The two superphosphate factories had been extended during 1954-1955 to bring up their annual capacities to 120,000 tons and 70,000 tons of superphosphate respectively.

The Second Five Year Plan

6. It took only three years to implement most of the projects of the first five-year plan. Hence, late in 1959 the second five-year industrial plan was drawn up and was incorporated in the first over-all five-year economic plan of the country. In this plan it was estimated that the annual fertilizer needs by 1965 would be about 2 million metric tons of nitrogenous fertilizer (15.5 percent N) and 556,000 metric tons of superphosphate (15 percent water soluble P_2O_5). Roughly 14% of the total needs would be for newly reclaimed arable land.

7. The plan therefore included projects which would satisfy completely those needs. In the choice of location for the new plants, the common factors were taken into consideration, viz., availability of suitable raw materials, transportation facilities, power, water and labour supply. Expansion of an already existing plant, whenever possible, was always preferred to the erection of a completely new one. Such a procedure not only cuts down on capital investment and plant running costs, but also saves on badly needed well trained technical personnel and skilled labour.

The total production capacity of nitrogen fertilizers by 1965 will be as shown in Table 1 (the total of 2,215,000 metric tons is based on 15.5%N). It is expected that during 1965 the newly constructed plants may not be working with full capacity and hence the actual production during that year would be around two million tons.

8. The superphosphate production will reach a total of 580,000 tons by 1965. The two existing factories will be doubled in capacity and a new plant will be erected in Asyut, Upper Egypt, with a capacity of 200,000 tons per year. This latter plant would supply the Asyut province and Upper Egypt regions south of Asyut with

their requirements of phosphatic fertilizers.

Raw Materials and Processes

A. Superphosphate

9. The rock phosphate used for the production of superphosphate is obtained from the Nile Valley Mines in the Sebaiya region 280 km north of Aswan (The ore contains 63.5 - 65.5% tricalcium phosphate). The sulphur dioxide for the manufacture of sulphuric acid has so far been obtained by the roasting of iron pyrites (imported mainly from Cyprus and Spain). However, the new plant at Asyut , as well as the extension of the Delta region plant (from 120,000 to 240,000 ton/year) will both employ elemental sulphur instead of pyrite. The use of sulphur instead of pyrite needs a lower capital investment and produces a cheaper acid.[1] Moreover, about 30,000 tons of sulphur will be produced from desulphurization of petroleum gases in a coking plant at Suez.

10. In the Delta region plant, the superphosphate is manufactured by the continuous Broad Field process to which we have introduced important modifications[2]. For example, the mixer length has been reduced so as to contain ten instead of twenty paddles, the mixer shaft speed has been increased from 100 to 500 R.P.M. and the pinion drive of the mixer shaft was replaced with a V - belt drive. As a result, the production capacity of each unit has been largely increased. The normal 5 ton/hour unit now produces 15 tons/hour and the normal 10 ton/hour unit now produces 20 tons/hour. Also the feeding device of sulphuric acid to the mixer has been modified. Conc. acid and water are now fed simultaneously to the mixer and thus the dilution and cooling systems could be dispensed with.

B. Nitrogen Fertilizers

11. The main raw material from which commercial nitrogen fertilizers are made is ammonia. The synthesis of ammonia is effected by reacting three volumes of hydrogen gas with one volume of nitrogen gas over a catalyst under pressure. Hydrogen for ammonia synthesis is commercially produced from various raw materials. Thus : -

(a) In the Nasr Fertilizer and Chemicals Co. plant at Suez, gases from a near by refinery, are reformed. These gases have the following average composition : Methane 35%; ethane 10%; ethylene 10%; propane 30%; higher hydrocarbons 15% .

(b) In the "Kima" plant at Aswan, cheap electric power is available from the Aswan Dam Hydro-electric Scheme, and therefore, hydrogen is produced by the electrolytic reduction of water.

(c) In the plant of Nasr Co. for Coke and Chemicals at Helwan

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1) Aries, R.S. and Newton R.D., Chemical Engineering Cost Estimation, Mc Graw-Hill Book Co., Inc., New York (1955) , page 9.

2) Shafik, M., The modification of Broad Field's acidulating units in Egypt, International Superphosphate Manufacturers' Association, London, September meeting 1953, paper L E 393 .

near Cairo, 360,000 cubic meters per day of coke oven gas are going to be produced (This quantity will be doubled in the second stage of production). The erection of the coking plant is now near completion. Partial oxidation of the coke oven gas will produce synthesis gas.

(d) Steam Cracking of Light Naphtha. About 120,000 metric tons per year of 70°C endpoint straightrun gasoline will result from our petroleum projects. Steam cracking of this light gasoline will produce the unsaturated hydrocarbons (to be used for the production of various petrochemicals) as well as, hydrogen, methane and ethane which will be used to produce synthesis gas for the manufacture of ammonia.

Factors Governing the Choice of Various Processes

12. The factors which governed the choice of a particular process were basically economic. Among these were the type and cost of raw material available, direct plant cost, cost of utilities, maintenance, efficiency of the particular process and hence the expected return on investment.

The following are three case studies:

(a) The "Kima" plant at Aswan. available cheap electric power could be used to produce electrolytic pure hydrogen and also could be used to produce nitrogen by air liquefaction followed by rectification.

The by-product oxygen available from both the electrolysis plant and from the air separation plant could be used to enrich the air used to oxidize the synthesised ammonia to nitrogen oxides.

(b) The Suez fertilizer plant. In this plant refinery of gases are mixed with steam and passed into a reforming furnace. This consists of a number of vertical nickel - chromium - iron alloy tubes mounted in a refractory furnace. Heat for the endothermic reaction is supplied by a number of fuel oil burners located at the bottom. Experience has shown that at the temperature of the reaction (around 1000°C), the Ni-Cr - Fe tubes corroded heavily and were a source of great trouble. It has recently been decided to replace this system by the partial oxidation process. It is estimated that the running cost per hour of the 260 ton/day ammonia plant will be diminished by about 18% of its present figure.

In the five nitric acid units erected in 1949 oxidation of the ammonia and absorption of nitrogen dioxide are both carried out under a pressure of about four atmospheres. The 6th unit erected in 1958 employed a process of oxidation under atmospheric pressure and absorption under a pressure of four atmospheres. We found this latter unit most satisfactory since it is characterised by a relatively higher ammonia combustion efficiency and lower catalyst consumption[3]. The same system is used in the "Kima" plant and will be adopted in the other plants.

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3) Sauchelli, V., The Chemistry and Technology of Fertilizers, Reinhold Publishing Corporation, New York (1960), pages 16-21.

(c) The Fertilizer Plant at Helwan

13. A coke oven plant will be operated in 1963 for supplying coke to the adjacent Iron and Steel Works at Helwan using imported coal. The production cost of the coke, and hence of the steel, will depend to a great extent on the utilization of the coal by-products obtained in the coking plant, particularly the coke oven gas. Moreover the utilization of the blast furnace gas itself is also of considerable importance. It was, therefore, decided to utilise the coke oven gas, and if possible the blast furnace gas, in the production of nitrogen fertilizer.

The plant in its first stage was planned to have a capacity of 170 tons/day of ammonia and to produce calcium ammonium nitrate fertilizer.

(1) Selection of the Cracking Process of the Gases.

In the production of synthetic ammonia, approximately 70% of the total production cost is due to the cost of raw materials and energy. When planning to erect such a plant, it was therefore necessary to investigate all possible processes, with the object of choosing the most suitable one characterized by a minimum cost of gas and energy.

The utilization of the blast furnace gas would be attractive because its content of nitrogen will be available for being used and the $CO + H_2$ contents can already cover a portion of the hydrogen required for the ammonia synthesis .

The cracking of coke oven gas can be effected by one of the following processes :

a. An exclusively thermal and discontinuous process under normal pressure using steam and blast furnace gas. Cracking is effected in two aggregates at about 1400°C. Each aggregate consists of a gas cracker and a regenerator.

b. An exclusively thermal and continuous cracking under pressure (about 25 atm.) by means of air enriched with oxygen and without using blast furnace gas. Oxygen would be obtained in an air separation plant.

c. The catalytic and continuous cracking under pressure by pressure by means of oxygen and by using blast furnace gas.

As the required nitrogen is provided by the blast furnace gas, cracking is only effected with pure oxygen under a pressure of 25 atm. Owing to the use of a catalyst, cracking takes place at 900-1000°C instead of 1400°C.

d. The catalytic and continuous cracking under pressure by means of steam and air enriched with oxygen, and without using blast furnace gas. As in processes b., and c. oxygen is obtained from an air separation plant.

In all the above four processes the coke oven gas should be desulphurized before cracking.

It should be mentioned here that the process of low temperature fractionation of coke oven gas was excluded from the outset, since the available quantity of coke oven gas of about 360.000 m^3/day can only give about 200.000 m^3/day of hydrogen whilst approximately 360.000 m^3/day of hydrogen are required. Furthermore this process has a much higher energy consumption.

(ii) Advantages and Disadvantages of the Various Processes :

The main advantages and disadvantages of the four cracking processes were studied and can be summarised as follows :

Process a. has the advantage that the heat requirements can be covered by blast furnace gas, so that the more valuable coke oven gas must not be burnt, and maximum ammonia yield related to the coke oven gas could be obtained. Although an air separation plant is not required, yet this process proved to be less economic compared with processes . and d. as it requires too much steam and owing to the fact that it must be operated discontinuously in a very voluminous plant which has a relatively high investment cost. Also cracking under normal pressure indirectly causes increased compression cost compared with cracking under pressure, as the volume of the cracked gas is 1.8 times higher than that of the coke oven gas.

The cracking processes under pressure work continuously and need considerable smaller reaction space, hence their investment costs are lower.

Process b. has the disadvantage that it operates at a higher cracking temperature than both processes c.,and d., resulting in a relatively higher coke oven gas and oxygen consumption.

Process d. has the disadvantage that the heat demand is provided by the coke oven gas itself, thus raising its consumption correspondingly.

However, the most economic process under the prevailing local conditions could only be found by computation taking into consideration the gas and energy consumption figures and their prices as well as the investment and operation costs.

The computation was based upon the following local prices[4]:

Electric energy	0.006 LE/KWH
Steam	0.750 LE/ton
Coke oven gas	3.500 LE/1000m^3
Blast furnace gas	0.700 LE/1000m^3

Table 2 shows that process d. has the least equipment cost, and table 3 shows also that the same process is cheaper to operate than the other processes, and was accordingly chosen as the most suitable for the fertilizer plant of Helwan.

The Impact of the High Dam on the Fertilizer Industry

14. The generated power in the U.A.R. is expected to reach 6.4 billion KWH in 1965. After the construction of the High Dam, the power generated will increase to 16.5 billion KWH (about January 1968). Industry will then find ample and cheap supply of power. The construction of the Dam will also enable the conversion of the present basin irrigation into the perennial system, and an extension in the arable land area. Accordingly, it is estimated that an additional 300,000 tons of nitrogen fertilizers (15.5% N) and 60,000 tons of superphosphate would be needed by 1970 over and

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4) One Egyptian Pound (LE) is officially equivalent to 2.87 U.S. Dollars.

above the estimated needs at the end of the present five-year economic plan (i.e 1965). It is therefore contenplated that an extra nitrogen fertilizer plant, with an annual capactiy of about 500,000 tons calcium ammonium nitrate (20.5%N), and a triple superphosphate plant with an annual capacity of about 46,000 tons, would be erected in Aswan and Sebaiya respectively where both cheap power and rock phosphate are available.

15. The phosphoric acid for the manufacture of the triple superphosphate would be produced from the phosphate rock by the electric furnace method. (It would also be used to manufacture conlex sodium phosphates). The ammonia for the nitrogen fertilizer plant would be produced either from electrolytic hydrogen, or by conversion of the off-gases from the electric iron smelting furnaces of an adjacent iron and steel plant. It is estimated that the electrolytic method would consume annualy about 1350 million KWH where as the CO-conversion of furnace gas would consume only 160 million KWH. Preference would be given to one method or the other after a detailed study of the economic of each, and taking into consideration the amount of power available for industry, the number of electrochemical or electro-thermal projects to be inplemented, and their respective capacities.

Current Research and Development

16. Apart from about 30,000 tons of petroleum sulphur that will be produced from the coking plant, the U.A.R. inports all its requirements of sulphur or pyrite for the manufacture of sulphuric acid. On the other hand, ample quantities of by-product hydrochloric acid are now available from the caustic soda industry and more will be available from chlorination processes in the petrochemical complex project. Accordingly, applied research in the field of fertilizers in the U.A.R. is directed towards utilization of more hydrochloric acid and econonizing on the sulphuric acid consumption.

17. For example, pilot plant experiments are now being undertaken to produce ammonium sulphate by double decomposition between ammonium carbonate and the locally available gypsum. The object of these experiments is to produce the country's needs of ammonium sulphate, which are growing rapidly, by this method instead of producing ammonium sulphate by direct reaction of ammonia and sulphuric acid.

18. Again, dicalcium phosphate can be produced by the reaction between hydrochloric acid and rock phosphate to liberate phosphoric acid, and then by addition of the proper quantity of milk of lime to precepitate the dicalcium phosphate. Field experiments on certain crops are now being conducted with dicalcium phosphate as fertilizer and the results are promising.

19. To econonize on the use of sulphuric acid in the manufacture of superphosphate, experiments are being carried out to reduce considerably the carbonate content of the rock phosphate (normally between 8% and 14%) by treatment with hydrochloric acid before addition of the sulphuric acid.

Table 2

Estimated Equipment cost for the processes a. - d.

Investment cost in LE	a.	b.	c.	d.
Coke oven gas holder	60,000	60,000	60,000	60,000
Cracked gas holder	60,000	-	-	-
Dry desulphurization	61,100	65,500	63,800	65,500
Cracking plant	981,000	282,000	300,000	303,000
Air Separation plant	-	675,000	413,000	350,000
Oxygen compressors	-	-	84,000	-
Oxygen/air compressors	-	147,000	-	117,000
Coke oven gas compressors	-	205,000	191,000	203,000
Blast furnace gas compressors	-	-	157,000	-
Mixed gas compressors	352,000	-	-	-
Conversion plants	185,000	108,000	108,000	108,000
Equipment cost without erection (LE)	1,699,100	1,542,500	1,376,800	1,206,500

Table 1

Total Production of Nitrogen Fertilisers by 1965 in Metric Tons (Based on 15.5%N)

Plant and location	Type of Fertiliser	Capacity (tons 15.5%N)	Remarks
Kima Plant (Aswan)	calcium ammonium nitrate	650,000	already producing
Nasr Fertiliser and Chemicals plant (Suez)	calcium nitrate	250,000	already producing
	ammonium sulphate	135,000	production just starting
	calcium nitrate	260,000	scheduled for production in 1965
	calcium ammonium Nitrate	200,000	
Nasr Coke and Chemicals plant (Helwan, near Cairo)	calcium ammonium nitrate	260,000	scheduled for production in 1965
	urea	260,000	
Petrochemical Complex (Alexandria)	calcium nitrate	200,000	scheduled for production in 1965
	Total	2,215,000	

Table 3

Comparison of consumption figures and cost per day to be considered for processes a. - d.

Consumption figures	a.		b.		c.		d.	
	Quantity	Cost LE	Quantity	Cost LE	Quantity	Cost LE	Quantity	Cost LE
Electric energy / KWH	114,500	687	140,200	841	111,000	666	102,800	617
Steam / ton	160	120	-	-	-	-	-	-
Coke oven gas / m^3	199,000	696	301,000	1055	235,000	822	272,000	953
Blast furnace gas / m^3	377,000	262	73,000	51	215,000	150	56,000	39
Depreciation of equipment (10% annually, divided by 300 working days).		566		514		459		402
Total per day (LE)		2331		2461		2097		2011

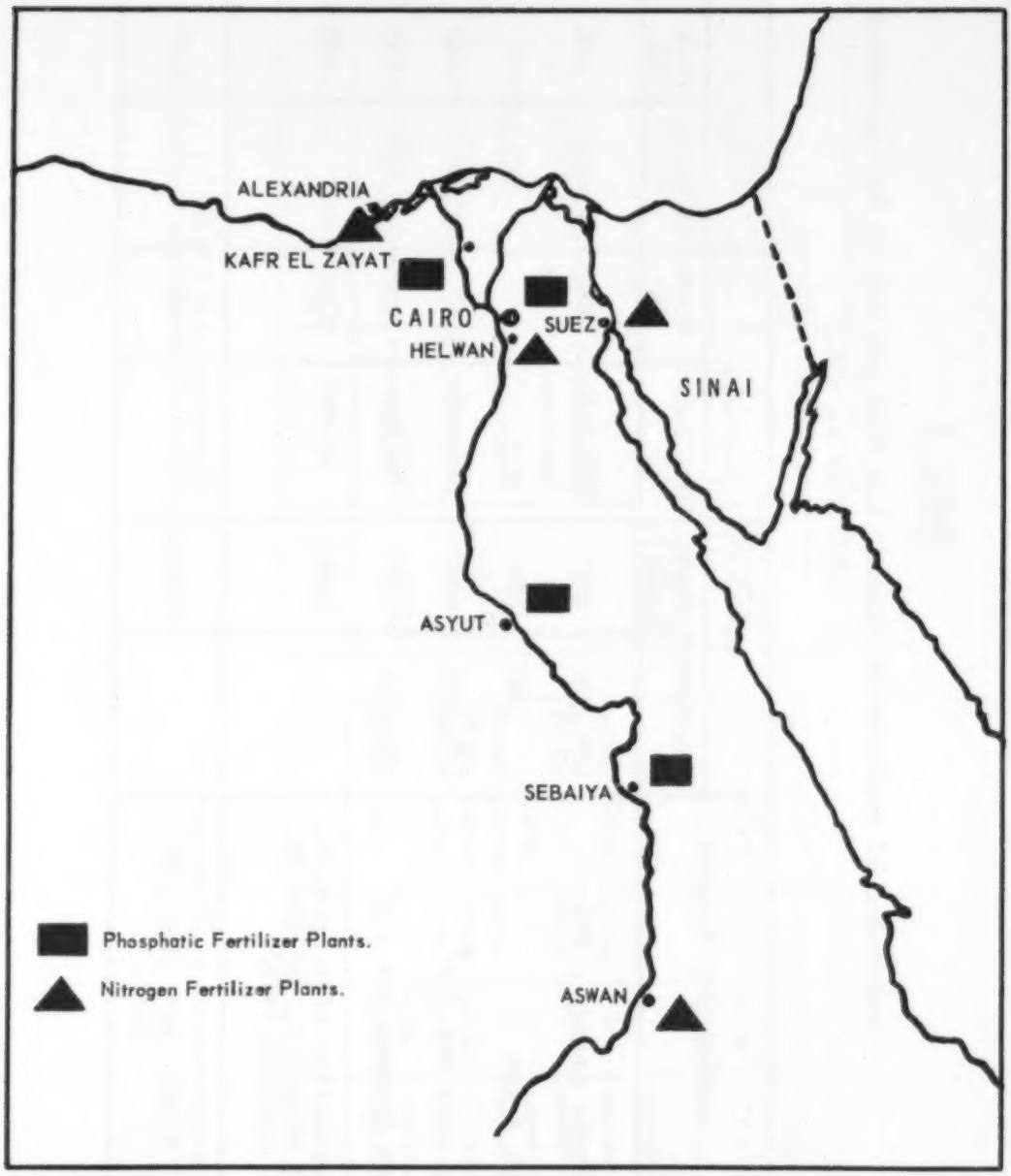

FIGURE 1

PRODUCTION OF FERTILIZERS IN THE U.A.R.

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(S u m m a r y)

Agriculture in the U.A.R. is dependent on relatively heavy use of fertilizer to maintain crop yields. Before the 1952 revolution most of our requirments of nitrogen fertilizers were imported. The implementation of the projects of the first five-year industrial plan raised our productive capacity of nitrogen fertilizers from 200,000 metric tons per year (15.5%N) to 1,035,000 tons per year, and of superphosphate from 100,000 tons to 190,000 tons per year. The projects of the first-five year industrial plan included the extension of the already existing two superphosphate plants, and the Suez nitrogen fertilizer plant, and the erection of a new plant at Aswan. The latter produces calcium ammonium nitrate (20.5%N) with a daily capacity of about 1600 tons.

However, the consumption of fertilizers was steadily increasing and in drawing up the first over-all five-year economic plan of the country (1960-1965), it was estimated that by 1965 the country's annual need of fertilizers would amount to two million tons of nitrogen fertilizers (15.5%N), and 580,000 tons of superphosphate. To satisfy these needs, the second five-year industrial plan which was incorporated in the over-all first five-year economic plan, included several new projects of fertilizer production. These are: (a)further extension of the Suez plant to produce an additional 460,000 tons per year (based on 15.5%N) of calcium nitrate and calcium ammonium nitrate; (b)the erection of a new plant at Helwan near Cairo to produce yearly about 520,000 tons of calcium ammonium nitrate and urea (15.5%N); (c)the erection of a new plant in Alexandria to produce 200,000 tons per year of calcium nitrate; (d)the erection of a new superphosphate plant at Asyut with an annual capacity of 200,000 tons; (e) the extension of the already existing two superphosphate plants by doubling their capacities and bringing these up to 240,000 tons and 140,000 tons of superphosphate per year respectively.

The raw materials for the superphosphate manufacture are, rock phosphate mined in the Nile valley at Sebaiya, and sulphuric acid. The sulphuric acid was manufactured in the old plants from imported pyrite, whereas the new extensions and new plants will use elemental sulphur since the capital investment is less than when pyrite is used. Furthermore 30,000 tons of petroleum sulphur will be available locally from the Suez petroleum coking plant.

The raw materials for the manufacture of nitrogen fertilizers are varied, depending on the locality of the plant.

(a) The Suez plant employs now a process of reforming refinery gases to produce synthesis gas. However, this system has caused a lot of trouble due to the frequent corrosion of the expensive stainless steel tubes of the reforming furnace. It has been decided to replace the reforming process by a partial oxidation process to save about 18% of the running cost per hour of the ammonia plant. In the Suez plant, the nitric acid was always produced by a pressure-pressure system. In the new unit added in 1958 an atmospheric-pressure system is used. This latter process is characterized by a higher ammonia combustion efficiency and lower catalyst consumption. The same process is employed in the "Kima" plant at Aswan and will be adopted in all other plants under construction.

(b) The "Kima" plant at Aswan. Ammonia is synthesised from pure hydrogen produced by the electrolysis of water and pure nitrogen produced by liquid air fractionation. The availability of cheap electric power from the Aswan Hydro-electric Scheme renders this process economic.

(c) The Helwan fertilizer plant will employ coke oven gas from the adjacent coking plant. Investigations were carried out of all possible processes of cracking this gas, thermally or catalytically, under normal or higher pressures, and either alone or mixed with blast furnace gas. Computation, on the basis of local prices of utilities and raw material gases, has swhown that a catalytic partial oxidation process of the coke oven gas alone under a pressure of about 25 atms. using air enriched with oxygen, was the most economic one.

(d) A petrochemical complex project will be implemented before 1965. The raw material is light naphtha which will be steam cracked to produce various petrochemicals as well as synthesis gas which will be used to produce 200,000 tons of calcium nitrate fertilizer (15.5%N).

The construction of the High Dam will allow an extension in the arable land area. This will necessitate the consumption of additional quantities of phosphatic and nitrogen fertilizers over and above the estimated needs of 1965. Since, electrical power will be then abundant and cheap, it is proposed to produce about 46,000 tons of triple superphosphate and 500,000 tons of calcium ammonium nitrate per year in the Aswan area, both projects being based on the utilization of cheap electrical power.

Applied research in the field of fertilizers in the U.A.R. is mainly directed towards economizing on the use of sulphuric acid in industry, since it is made from imported sulphur or pyrite, and at the same time utilizing more by-product HCl. Thus for example, pilot plant experiments are now being carried out on the manufacture of ammonium sulphate by double decomposition between the locally available gypsum and ammonium carbonate. Also we are trying to lower the carbonate content of rock phosphate by using HCl.

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